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GEORGE OTIS SMITH, DIRECTOR

BULLETIN 463

RESULTS OF SPIRIT LEVELING IN ARIZONA

1899 TO 1909, INCLUSIVE

R. B. MARSHALL, CHIEF GEOGRAPHER

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

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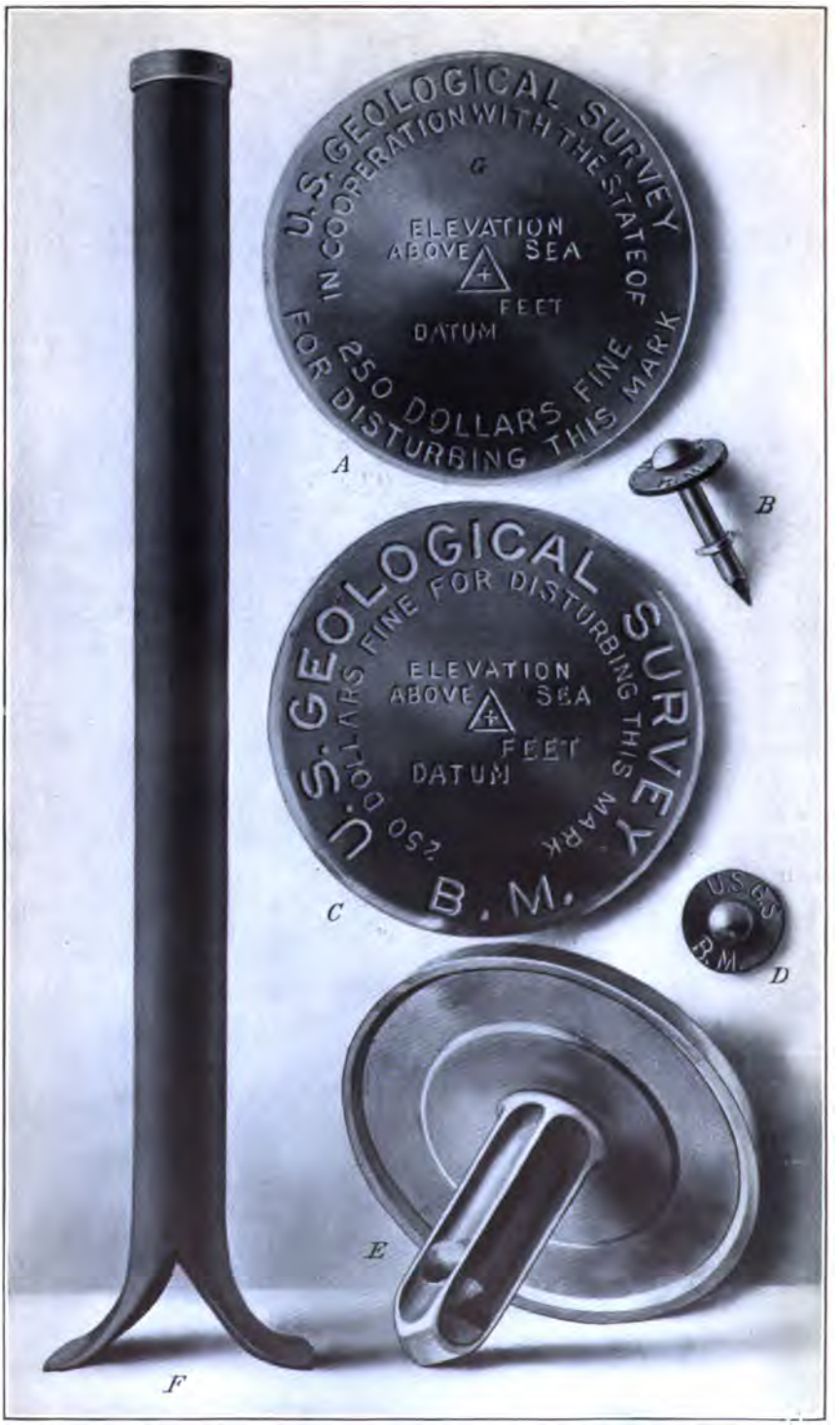

GEOLOGICAL SURVEY BENCH MARKS.

A, Tablet used in cooperating States. The State name is inserted at *G*.
B and *D*, Copper temporary bench mark, consisting of a nail and copper washer.
A, *C*, and *E*, Tablets for stone or concrete structures.
F, Iron post used where there is no rock.

RESULTS OF SPIRIT LEVELING IN ARIZONA, 1899 TO 1909 INCLUSIVE.

R. B. MARSHALL, Chief Geographer.

INTRODUCTION.

Scope of the work.—All results of spirit leveling in Arizona previously published by the United States Geological Survey and all the results of later work are included in this report, rearranged by quadrangles. The elevations are based on preliminary heights of bench marks along the precise level line of the Coast and Geodetic Survey from San Diego, Cal., via Mellen and Flagstaff, Ariz., to Albuquerque, N. Mex., and on the precise line of the United States Geological Survey between Yuma, Ariz., and the Arizona-New Mexico line.

Personnel.—The field work previous to 1903 was done under the general direction of R. U. Goode, geographer; that for 1903 to 1906, inclusive, under E. M. Douglas, geographer; that for 1907 under R. B. Marshall, geographer; and the later work under T. G. Gerdine, geographer, under the general direction of R. B. Marshall, chief geographer. The names of the various levelmen are given in the introduction to each list. The office work of computation, adjustment, and preparation of lists was done mainly by S. S. Gannett, geographer, and D. H. Baldwin, topographer, and since 1907 under the general direction of E. M. Douglas, geographer.

Classification.—The elevations are classified as precise or primary according to the methods employed in their determination. For precise level lines instruments and rods of the highest grade are used, each line is run both forward and backward, and every precaution is taken to guard against error. The allowable divergence between the forward and the backward lines in feet is represented by the formula $0.017\sqrt{D}$, in which D is the distance in miles between bench marks. For primary lines standard Y levels are used; lines are run in circuits or are closed on precise lines, with an allowable closing error in feet represented by $0.05\sqrt{D}$, in which D is the length of the circuit

in miles, sufficient care being given to the work to maintain this standard. For levels of both classes careful office adjustments are made, the small outstanding errors being distributed over the lines.

Bench marks.—The standard bench marks are of two forms. The first form is a circular bronze or aluminum tablet (*C* and *E*, Pl. I), 3½ inches in diameter and one-quarter inch thick, having a 3-inch stem, which is cemented in a drill hole in solid rock in the wall of some public building, a bridge abutment, or other substantial masonry structure. The second form (*F*, Pl. I), used where masonry or rock is not available, consists of a hollow wrought-iron post 3½ inches in outer diameter and 4 feet in length. The bottom is spread out to a width of 10 inches in order to give a firm bearing on the earth. A bronze or aluminum-bronze cap is riveted over the top of the post, which is set about 3 feet in the ground. A third style of bench mark with abbreviated lettering (*B* and *D*, Pl. I) is used for unimportant points. This consists of a special copper nail 1½ inches in length driven through a copper washer seven-eighths inch in diameter. The tablets as well as the caps on the iron posts are appropriately lettered, and where States have cooperated in the work the fact of such cooperation is indicated by the addition of the State name (*G*, Pl. I).

The numbers stamped on the bench marks described in the following pages represent the elevations to the nearest foot as determined by the levelman. These numbers are stamped with $\frac{3}{16}$-inch steel dies on the tablets or post caps to the left of the word "feet." The office adjustment of the notes and the reduction to mean sea-level datum may so change some of the figures that the original markings are 1 or 2 feet in error. It is assumed that engineers and others who have occasion to use the bench-mark elevations will apply to the Director of the United States Geological Survey, at Washington, D. C., for the adjusted values, and will use the markings as identifications numbers only.

Datum.—All United States Geological Survey elevations are referred to mean sea level, which is the level that the sea would assume if the influence of winds and tides were eliminated. This level is not the elevation determined from the mean of the highest and the lowest tides, nor is it the half sum of the mean of all the high tides and the mean of all the low tides, which is called the half-tide level. *Mean sea level is the average height of the water, all stages of the tide being considered.* It is determined from observations made by means of tidal gages placed at stations where local conditions, such as long, narrow bays, rivers, and like features, will not affect the height of the water. To obtain even approximately correct results these observations must extend over at least one lunar month, and if accuracy is desired they must extend over several years. At ocean stations the half-tide level and the mean sea level usually differ but little. It is

assumed that there is no difference between the mean sea level as determined from observations in the Atlantic Ocean, the Gulf of Mexico, or the Pacific Ocean.

The connection with tidal stations for bench marks in certain areas that lie at some distance from the sea coast is still uncertain, and this fact is indicated by the addition of a letter or word to the right of the word "Datum" on tablets or posts. For such areas corrections for published results will be made from time to time as the precise-level lines of the United States Geological Survey or other Government organizations are extended.

Topographic maps.—Maps of the following quadrangles wholly or partly in Arizona have been published by the United States Geological Survey up to May 1, 1911. They may be obtained (except as noted) for 5 cents each or $3 a hundred, on application to the Director of the Survey at Washington, D. C.

Bisbee.
Bisbee special.
Bradshaw Mountains.[1]
Bright Angel[2] (10 cents).
Camelsback.
Camp Mohave (Ariz.-Nev.-Cal.).
Canyon de Chelly (Ariz.-N. Mex.).
Chino.
Clifton.
Congress.[1]
Desert Well.
Diamond Creek
Echo Cliffs.[3]
Florence.
Fort Defiance (Ariz.-N. Mex.).
Fort McDowell.
Globe.
Globe special.
Holbrook.
Jerome.[1]
Kaibab.[2]
Marsh Pass.
Mount Trumbull.
Needles special (Ariz.-Cal.).
Nogales.
Patagonia.
Prescott.[1]
Ray.
Roosevelt.
Sacaton.
St. Johns (Ariz.-N. Mex.).
St. Thomas (Nev.-Ariz.).
San Francisco Mountain.
Shinumo[2] (10 cents).
Tombstone mining (10 cents).
Tombstone special.
Tucson.
Tusayan.
Verde.
Vishnu[3] (10 cents).
Yuma (Cal.-Ariz.).

PRECISE LEVELING.

Benson, Casa Grande, Cochise, Dragoon, Gila Bend, Langhorne, Maricopa, Mohawk, Patagonia, Red Rock, San Simon, Sentinel, Tucson, Wellton, and Yuma Quadrangles.

COCHISE, MARICOPA, PIMA, PINAL, AND YUMA COUNTIES.

The following elevations are the unadjusted results of a precise-level line run eastward along the Southern Pacific Railroad from Yuma to Tucson by M. S. Bright in 1905, and from the New Mexico

[1] Bradshaw Mountains, Congress, and Jerome sheets show parts of Prescott quadrangle on a larger scale.
[2] Bright Angel and Shinumo sheets show parts of Kaibab quadrangle on a larger scale.
[3] Vishnu sheet shows part of Echo Cliffs quadrangle on a larger scale.

line near San Simon to Tucson by W. A. E. Hult and T. A. Green in 1907.

YUMA QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

	Feet.
Yuma, in east end of second pier of railroad bridge; aluminum tablet stamped "137 S. B."	138.100
Yuma, in front of station; top of east rail	141.86
Yuma Heights, in front of station; top of west rail	197.5
Ivalon, in front of station; top of south rail	214.0
Ivalon, 15 feet south of switch stand; top of vertical rail 340	212.19
Ivalon, north of track, 4 feet north of signboard; iron post	212.253
Milepost 736, 400 feet east of, 4 feet south of track; top of vertical rail 420	217.14
Araby, in front of station; top of south rail	214.71

WELLTON QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Milepost 740, 3 feet north of, south of track; iron post stamped "213 Y"	213.866
Blaisdell, 1.5 miles west of, 75 feet north of track, west of road; iron post	227.867
Blaisdell, at southeast corner of station; iron post stamped "188 Y"	188.904
Blaisdell, in front of station; top of rail	188.0
Milepost 748, 50 feet north of, south of track; top of vertical rail	181.50
Milepost 748, 250 feet northeast of, 40 feet east of track; iron post	180.379
Milepost 749, 40 feet north of; top of vertical rail	187.01
Milepost 751, 330 feet west of, 5 feet north of track; top of vertical rail	190.05
Gila City, in front of station; top of rail	189.69
Gila City, at northwest corner of McDaniel's store; iron post	187.308
Milepost 754, 100 feet northwest of; top of vertical rail 35	195.23
Milepost 755, opposite, 50 feet north of track; iron post	192.177
Bridge 758-A, 120 feet west of, 40 feet south of track, 280 feet east of milepost 758; iron post	223.165
Liqurta, in front of signboard; top of rail	229.1
Milepost 761, 330 feet west of, 35 feet north of track, at east end of cut; iron post	256.360
Bridge 762-A, west end of; top of vertical rail 48	234.18
Milepost 763, 330 feet east of; top of vertical rail 1850	233.92
Milepost 764, 26 feet south of, 45 feet south of track; iron post	231.452
Milepost 767, 4 feet east of, 50 feet south of track; iron post	229.815
Wellton, in front of station; top of rail	257.80
Wellton, in northwest foundation of store, west of water tank, in northwest corner; top of bolt	256.58
Milepost 770, 4 feet northwest of, 45 feet south of track; iron post	285.890
Bridge 772-A, 330 feet east of, 50 feet north of track; iron post	304.787
Milepost 776, opposite, 60 feet north of track; iron post	348.378

MOHAWK QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Milepost 779, opposite, 60 feet north of track; iron post	348.50
Colfred siding, west end of, 500 feet east of milepost 782, 50 feet north of track; iron post	328.359

	Feet.
Milepost 785, opposite, 50 feet north of track; iron post	339.374
Milepost 788, opposite, 50 feet north of track; iron post	417.803
Mohawk, 100 feet north of station, 50 feet north of track; iron post	544.813
Mohawk, 500 feet east of station, 255 feet north of track, set flush with ground in concrete, marked by rock mound; iron post	544.832
Mohawk, in front of station; top of rail	545.50
Milepost 794, opposite, 50 feet north of track; iron post	415.998
Kim, in front of signboard; top of rail	405.13
Milepost 768, 0.5 mile west of, 50 feet north of track, 400 feet north of old house; iron post	355.225
Milepost 800, 4 feet east of, 50 feet south of track; iron post	401.603
Milepost 803, 4 feet east of, 50 feet south of track; iron post	417.513
Milepost 806, 4 feet east of, 50 feet south of track; iron post	459.87

SENTINEL QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Milepost 810, opposite, 50 feet north of track; iron post	488.540
Aztec, in front of station; top of rail (railroad elevation 494)	497.08
Maricopa-Yuma County line, 50 feet north of track; iron post	485.489
Milepost 816, opposite, 50 feet north of track; iron post	519.865
Stanwix, in front of signboard; top of rail	554.4
Milepost 819, opposite, 50 feet north of track; iron post	549.856
Milepost 822, 50 feet north of track, opposite milepost; iron post	611.024
Sentinel, 0.3 mile west of, 70 feet north of track, 50 feet north of forks of road, set in concrete flush with ground; iron post	692.863
Sentinel, in front of station; top of rail	689.31
Milepost 826, 100 feet northeast of, 50 feet north of track; iron post	705.735
Tartion, in front of signboard; top of rail	728.96
Tartion, opposite milepost 832, 50 feet north of track; iron post	726.787
Milepost 835, opposite, 50 feet north of track; iron post	762.66
Painted Rock, in front of station; top of rail	727.4
Painted Rock, 40 feet north of track, opposite signboard; iron post	725.92
Milepost 842, 4 feet west of, 50 feet south of track; iron post	715.96

GILA BEND QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Milepost 845, 5 feet west of, 50 feet south of track; iron post	737.43
Milepost 848, 250 feet east of, 40 feet north of track; iron post	728.129
Smurr, in front of signboard; top of rail	727.55
Milepost 851, 8 feet west of, 50 feet south of track; iron post	725.857
Gila Bend, 0.5 mile west of station, 50 feet south of track; iron post	735.500
Gila Bend, in front of station; top of rail	737.6
Milepost 855, 700 feet east of, 50 feet north of track, at west side of road crossing, set flush with ground in concrete; iron post	744.774
Milepost 855, 700 feet east of, 4 inches west of, above iron post, in concrete 1 foot below surface of ground; aluminum tablet	743.468
Milepost 857, 6 feet west of, 50 feet south of track; iron post	796.656
Coledon, in front of signboard; top of rail	818.64
Milepost 860, 4 feet west of, 50 feet south of track; iron post	928.420
Milepost 863, 5 feet west of, 50 feet south of track; iron post	1,051.204
Milepost 866, 200 feet west of, 50 feet north of track; iron post	1,194.126

MARICOPA QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

	Feet.
Ocapos, in front of signboard; top of rail	1,273.57
Milepost 869, 4 feet east of, 75 feet south of track; iron post	1,335.859
Milepost 872, 5 feet south of, 50 feet south of track; iron post	1,486.34
Estrella, in front of station; top of rail	1,522.6
Milepost 875, 5 feet north of, 45 feet south of track; iron post	1,480.509
Buchan, 70 feet south of track, 4 feet south of milepost 878; iron post	1,417.838
Milepost 881, 4 feet south of, 60 feet south of track; iron post	1,357.815
Milepost 884, 4 feet south of, 60 feet south of track; iron post	1,301.58
Milepost 887, 530 feet east of, 60 feet north of track, 100 feet south of road; iron post	1,283.128
Heabon, 4 feet south of milepost 890, 50 feet south of track; iron post	1,217.596
Milepost 893, opposite, 50 feet north of track; iron post	1,151.909
Maricopa, 75 feet northwest of station; iron post stamped "1175 PHNX"	1,174.891
Maricopa, in front of station; top of rail	1,174.40
Maricopa, 0.25 mile southeast of, 120 feet west of bridge A, northeast of track, 100 feet east of road crossing, set flush with ground in cement; iron post	1,176.986
Maricopa, 0.25 mile southeast of, 120 feet west of bridge A, northeast of track, 100 feet east of road crossing, 4 inches to east of above iron post, in cement 1 foot below surface of ground; aluminum tablet	1,175.748
Milepost 897, opposite, 40 feet north of track, set flush with ground with collar of cement marking northwest end of base line; iron post	1,179.527

CASA GRANDE QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Milepost 899, 2 feet northeast of, 50 feet southwest of track; iron post stamped "1200 PHNX"	1,199.995
Milepost 902, opposite, 40 feet north of track, set flush with ground with collar of cement marking southeast end of base line; iron post	1,225.706
Sweetwater, northeast of track, midway between section house and well; iron post stamped "1297 PHNX"	1,297.022
Sweetwater, in front of station; top of rail	1,298.29
Milepost 909, 6 feet south of, 45 feet south of track; iron post	1,338.205
Nunez siding, in front of station; top of rail	1,340.7
Milepost 912, 4 feet southwest of, 50 feet south of track; iron post	1,333.016
Milepost 915, opposite, 50 feet east of track, in north angle of forks of road at road crossing, in granite; aluminum tablet	1,367.132
Casa Grande, in front of station; top of rail	1,397.93
Casa Grande, 0.4 mile southeast of, 90 feet northeast of track, 10 feet southeast of gate of private road crossing, in granite; aluminum tablet	1,404.582
Arizola, in front of station; top of rail	1,434.8
Milepost 922, 100 feet north of, 50 feet north of track, in granite; aluminum tablet	1,450.196

	Feet.
Milepost 925, 700 feet west of, in northeast end of east pier of bridge D; aluminum tablet	1,480.510
Tote, in front of signboard; top of rail	1,511.2
Milepost 929, opposite, 50 feet northwest of track, in granite; aluminum tablet	1,532.209
Eloy, in front of signboard; top of rail	1,565.3
Milepost 933, 400 feet southeast of, in west end of north pier of bridge A; aluminum tablet	1,578.802

RED ROCK QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Picacho, in front of station; top of rail	1,620.29
Picacho, 11 feet northeast of track, in north corner of northwest concrete pier of water tank; aluminum tablet	1,621.362
Milepost 940, opposite, 50 feet northeast of track, in granite rock; aluminum tablet	1,706.877
Wymola siding, in front of station; top of rail	1,765.3
Wymola siding, opposite milepost 943, southeast of track, in granite rock; aluminum tablet	1,769.399
Red Rock, 3.8 miles northwest of, in south end of east pier of bridge B; aluminum tablet	1,809.29
Red Rock, in front of station; top of rail	1,867.08
Red Rock, 15 feet southeast of station, 15 feet west of track; iron post stamped "1856 NOGLS"	1,867.229
Milepost 953, 50 feet west of, 4 feet southeast of gate; iron post stamped "1899 NOGLS"	1,910.486
Naviska siding, 0.5 mile north of, 200 feet north of track, 12 feet west of road, at Pima-Pinal county line; iron post stamped "1940 NOGLS"	1,951.516

LANGHORNE QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Desert Well, 75 feet west of corner of corral; iron post stamped "1960 NOGLS"	1,971.743
Marana siding, in front of station; top of rail	1,993.79
Rillito, 2.5 miles northwest of, in southwest corner of concrete bridge; aluminum tablet	2,011.981
Rillito, in north corner of second foundation stone on west side of water tank; aluminum tablet	2,056.482
Rillito, in front of station; top of rail	2,068.69
Milepost 969, 150 feet northeast of, 100 feet east of track, at fence corner; iron post stamped "2109 NOGLS"	2,120.769
Cortoro siding, in front of station; top of rail	2,155.32
Milepost 972, 100 feet southeast of, in east end of south pier of bridge B; aluminum tablet	2,189.040
Milepost 975, 1,000 feet east of, 10 feet west of road fork; iron post stamped "2219 NOGLS"	2,230.798
Jaynes siding, in front of station; top of rail	2,243.89
Milepost 977, 125 feet south of, in east end of south pier of bridge A; aluminum tablet	2,258.003

TUCSON QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

	Feet.
Stockham siding, in front of station; top of rail	2,314.75
Stockham ranch house, 60 feet west of, 5 feet south of gate; iron post stamped "2313 NOGLS"	2,324.899
Tucson, 88 feet southeast of Pima courthouse, in southeast corner of yard, set flush with ground; aluminum tablet	2,374.196
Tucson, in front of station; top of rail	2,388.2
Polvo siding, 0.8 mile west of, 100 feet south of track, at road crossing, north side of road forks, 4 feet north of fence corner; iron post stamped "2481 NOGLS"	2,493.229
Wilmot siding, near west end of, south side of track, at northeast corner of fence around section house; iron post stamped "2651 NOGLS"	2,663.244
Rankin siding, 0.7 mile west of, 95 feet south of track, west side of road, 5 feet north of fence corner; iron post stamped "2770 NOGLS"	2,782.421
Esmond siding, 2.2 miles west of, 125 feet north of milepost 995, 100 feet north of track, south side of road; iron post stamped "2903 NOGLS"	2,915.435
Esmond siding, in front of station; top of rail	3,016.1
Vail, 2.8 miles west of, 145 feet northwest of milepost 999, 15 feet east of old gate; iron post stamped "3096 NOGLS"	3,108.502
Vail, in front of station; top of rail	3,232.1
Vail, 220 feet northeast of station, 5 feet east of gate; iron post stamped "3220 NOGLS"	3,232.480
Irene siding, 3.2 miles west of, 6 feet north of railroad, in north end of concrete culvert 1004-A; aluminum tablet stamped "3226 1907 206"	3,237.895
Irene siding, 2.1 miles west of, at milepost 1005, on south side of track; top of first bolt from east end of bridge, marked "3265"	3,276.84
Irene siding, 0.5 mile west of, south of track in east side of coping stone at west end of iron railroad bridge; aluminum tablet stamped "3328 1907 203"	3,340.179
Irene siding, in front of station; top of rail	3,363.0
Pantano, 1 mile west of, 800 feet east of milepost 1010, in southeast corner of south abutment of culvert 1010-A; aluminum tablet stamped "199 II 1907"	3,489.995

PATAGONIA QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Pantano, in front of station; top of rail	3,546.6
Kadmon siding, 4 miles west of, 1,000 feet north of milepost 1013 at road crossing; iron post stamped "3608 NOGLS"	3,618.963
Kadmon siding, 3 miles west of, 150 feet east of milepost 1014; top of rail section driven in ground, marked "3661"	3,671.42
Kadmon siding, 1 mile west of, 1 mile north of milepost 1016; iron post stamped "3757 NOGLS"	3,767.910
Kadmon siding, in front of station; top of rail	3,821.9

BENSON QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

	Feet.
Mescal, 3 miles west of, 500 feet east of milepost 1019, in line of telegraph poles; iron post stamped "3905 NOGLS"	3,915.849
Mescal, 2 miles east of, 150 feet west of milepost 1020, on top of rail section driven in ground; marked "3943"	3,953.96
Pima-Cochise county line, top of rail	4,017.1
Mescal, 800 feet west of station, at northeast corner of section-house fence; iron post stamped "4046 NOGLS"	4,056.922
Mescal, in front of station; top of rail	4,062.9
Mescal, 1 mile east of, 400 feet west of milepost 1023, in south guard-rail of bridge 1022-B; top of bolt head marked "3998"	4,009.248
Chamiso siding, 2 miles west of, 45 feet south of milepost 1025; iron post stamped "3883 NOGLS"	3,894.079
Benson, 3.25 miles west of, 50 feet south of milepost 1028; iron post stamped "3784"	3,794.876
Benson, at northwest corner of Virginia Hotel; iron post stamped "3573 NOGALES"	3,583.943
Benson, in front of station; top of rail	3,580.3
Visnaga siding, 2 miles west of, 75 feet south of milepost 1034; iron post	3,634.219
Visnaga siding, in front of station; top of rail	3,785.8
Sibyl, 2.5 miles west of, 200 feet west of milepost 1037, 100 feet south of track; iron post	3,834.996
Sibyl, 0.5 mile west of, 75 feet south of milepost 1039; iron post stamped "170 1907"	3,978.604
Sibyl, in front of station; top of rail	4,007.3
Ochoa siding, 3 miles west of, 300 feet west of milepost 1043, in center of south end of culvert 1042 F; aluminum tablet stamped "165 H 1907"	4,187.584
Ochoa siding, in front of station; top of rail	4,324.8
Ochoa siding, 150 feet east of water tank, 50 feet south of track, in top of granite bowlder; aluminum tablet stamped "162 H 1907"	4,332.141
Lancha siding, 0.5 mile west of, 50 feet south of milepost 1049; iron post stamped "159½ H 1907"	4,464.010
Lancha siding, in front of station; top of rail	4,491.6

DRAGOON QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Dragoon, 1.5 miles west of, 500 feet west of milepost in top of south end of culvert 1050-P; top of spike head	4,559.01
Dragoon, 0.5 mile west of, 75 feet south of milepost 1052; iron post stamped "156 H 1907"	4,595.209
Dragoon, in front of station; top of rail	4,613.5
Manzoro siding, 2 miles west of, 100 feet south of milepost 1055; iron post stamped "153 H 1907"	4,528.967

COCHISE QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Manzoro siding, in front of station; top of rail	4,440.6
Cochise, 4.5 miles west of, 100 feet north of milepost 1058; iron post stamped "150 H 1907"	4,380.768

	Feet.
Cochise, 2.5 miles west of, 150 feet west of milepost 1060, in east end of north guardrail of bridge "1059-E;" bolt head	4,307.15
Cochise, 1.5 miles west of, 100 feet south of milepost 1061; iron post stamped "147-H 1907"	4,277.550
Cochise, in front of station; top of rail	4,230.3
Hado siding, 4.25 miles west of, 100 feet north of milepost 1064; iron post stamped "144 H 1907"	4,157.981
Hado siding, 0.25 mile west of, 150 feet north of milepost 1068; iron post stamped "140½ H 1907"	4,144.021
Willcox, 2.5 miles west of, 100 feet north of milepost 1071; iron post stamped "137 H 1907"	4,162.719
Willcox, 100 feet south of station, in front of weather bureau office; iron post stamped "134½ H 1907"	4,166.360
Willcox, in front of station; top of rail	4,165.6
Drury siding, 3 miles west of, 100 feet north of milepost 1075; iron post stamped "133 H 1907"	4,173.006
Glade, 2 miles west of, 100 feet north of milepost 1079; iron post stamped "129 H 1906"	4,319.728
Glade, in front of station; top of rail	4,375.2
Glade, 1 mile east of, 100 feet north of milepost 1082; iron post stamped "126 H 1907"	4,363.936
Alrich siding, 1.25 miles west of, 100 feet south of milepost 1085; iron post stamped "123 H 1907"	4,200.322
Aldrich siding, in front of station; top of rail	4,148.5
Luzena siding, 1.8 miles west of, 100 feet north of milepost 1088; iron post stamped "120 H 1907"	4,061.279
Luzena siding, in front of station; top of rail	3,984.7
Bowie, 6 miles west of, 100 feet north of milepost 1091; iron post stamped "117 H 1907"	3,966.441
Bowie, 3 miles west of, 100 feet north of milepost 1094; iron post stamped "114 H 1907"	3,868.301

SAN SIMON QUADRANGLE.

Yuma east along Southern Pacific R. R. to New Mexico line (portion of line).

Bowie, in front of station; top of rail	3,761.5
Bowie, at southwest corner of Solomon & Wickersham's store; iron post stamped "111 H 1907"	3,758.96
Olga siding, 5.25 miles west of, 100 feet north of milepost 1100; iron post stamped "108 H 1907"	3,697.731
Olga siding, 3.25 miles west of, 100 feet north of milepost 1102; iron post stamped "106 H 1907"	3,668.834
Olga siding, in front of station; top of rail	3,623.9
San Simon, 7 miles west of, 100 feet north of milepost 1106; iron post stamped "102 H 1907"	3,612.558
San Simon, 4 miles west of, 100 feet north of milepost 1109; iron post stamped "99 H 1907"	3,592.196
San Simon, 75 feet north of track, 100 feet west of station; iron post stamped "95½ H 1907"	3,611.340
San Simon, in front of station; top of rail	3,612.3
Bawtry siding, 2.2 miles west of, in center of south guardrail of bridge 1113-D, opposite milepost 1114; top of bolt head	3,798.28

	Feet.
Bawtry siding, 1.2 miles west of, 75 feet south of milepost 1115; iron post stamped "93 H 1907"	3,625.433
Bawtry siding, in front of station; top of rail	3,678.0
Vanar, 3.5 miles west of, opposite milepost 1117, in base of telegraph pole; spike (railroad bench mark marked "3719.94")	3,722.40
Vanar, 2.5 miles west of, 75 feet north of milepost 1118; iron post stamped "90 H 1907"	3,793.239
Vanar, in front of station; top of rail	3,905.3
Cavot, 3 miles west of, 75 feet south of milepost 1121; iron post stamped "87 H 1907"	3,908.225

Jerome and Williams Quadrangles.

COCONINO AND YAVAPAI COUNTIES.

The following are the unadjusted results of a line of precise levels from Del Rio north along the Santa Fe, Prescott & Phoenix Railway to Ashfork, thence east along the Atchison, Topeka & Santa Fe Railway to Williams. The leveling was done in 1905 by M. S. Bright.

In 1909 the precise line of the Coast and Geodetic Survey along the Atchison, Topeka & Santa Fe Railway redetermined certain bench marks between Ashfork and Williams, as shown in the following list. The unadjusted elevations determined by the Coast and Geodetic Survey, approximately 1.9 feet lower than those obtained by the United States Geological Survey, have been adopted.

JEROME QUADRANGLE.

Del Rio north along Santa Fe, Prescott & Phoenix Ry. to Ashfork (portion of line).

	Feet.
Del Rio, 5.1 miles northeast of, 1 mile northeast of Valley siding, north of road, 100 feet north of track; iron post stamped "4495 PRSCT"	4,501.823
Milepost 25, 10 feet west of, 40 feet north of track; iron post	4,672.047
Cedar Glade, 1 mile south of, 40 feet north of milepost 22, 70 feet west of track; iron post	4,648.859
Cedar Glade, in front of station; top of rail	4,648.3

WILLIAMS QUADRANGLE.

Del Rio north along Santa Fe, Prescott & Phoenix Ry. to Ashfork (portion of line).

Milepost 19, 10 feet south of, 40 feet west of track, 20 feet west of road; iron post	4,750.973
Rock Butte siding, 0.25 mile south of, 40 feet west of track, at road crossing, 3 feet north of milepost 16; iron post	4,923.980
Rock Butte siding, in front of station; top of rail	4,934.6
Little Hell Canyon, 300 feet north of, 210 feet north of milepost 13, 50 feet east of track; iron post	5,007.177
Meath siding, 0.5 mile south of, at north end of cut, 40 feet east of track; iron post	5,098.220
Meath siding, in front of station; top of rail	5,118.1
Ashfork, 6.5 miles south of, 0.5 mile south of milepost 6 at south end of cut, 40 feet east of track; iron post	5,190.055

	Feet.
Ashfork, 3 miles south of, opposite milepost 3, 50 feet east of track; iron post	5,126.027
Ashfork, 300 feet south of Atchison, Topeka & Santa Fe Ry. station, at southeast corner of Lewis Avenue and Third Street; iron post, Coast and Geodetic Survey unadjusted value	5,138.854
Ashfork, in front of station; top of rail	5,135.0

Ashfork east along Atchison, Topeka & Santa Fe Ry. to Williams.

Bridge A-401, south end of, in east stone pier; aluminum tablet, Coast and Geodetic Survey unadjusted value	5,132.053
Milepost 397, 4 feet west of, 50 feet north of track, in rock outcrop; aluminum tablet, Coast and Geodetic Survey unadjusted value	5,443.781
Denair siding, in front of station; top of rail	5,507.5
Milepost 394, 6 feet west of, in rock outcrop; aluminum tablet, Coast and Geodetic Survey unadjusted value	5,711.163
Fairview, 35 feet north of track, at south end of stone fence; iron post, Coast and Geodetic Survey unadjusted value	5,935.120
Bridge 388-D, in east pier, south of track, in second stone from top; aluminum tablet	6,308.572
McClellan siding, in front of station; top of rail	6,433.4
Milepost 385, 40 feet southwest of, 50 feet west of track, in rock outcrop; aluminum tablet, Coast and Geodetic Survey unadjusted value	6,566.224
Supai, 80 feet northwest of station, 35 feet north of track; iron post, Coast and Geodetic Survey unadjusted value	6,959.381
Williams, in front of station; top of rail	6,759.0
Williams, at northwest corner of Grand Canyon Hotel; iron post stamped "6770," Coast and Geodetic Survey unadjusted value	6,765.909

PRIMARY LEVELING.

Arivaca, Benson, Bisbee, Dragoon, Nogales, Patagonia, Red Rock, Reef, Tucson, and Winkelman Quadrangles.

COCHISE, PIMA, PINAL, AND SANTA CRUZ COUNTIES.

The elevations in the following list are based upon precise levels along the Southern Pacific Railroad from Yuma. (Additional elevations in the Benson, Dragoon, Patagonia, Red Rock, and Tuscon quadrangles are given in list of results of precise leveling, pages 11-13.)

The leveling in the Winkelman quadrangle was done by Thomas Winsor in 1900, by M. S. Bright in 1904, and by L. F. Biggs in 1909; that in the Benson quadrangle by Chester Irvine in 1901, by Bright in 1903 and 1904, and by R. H. Sargent in 1905. The leveling in the Arivaca, Nogales, and Red Rock quadrangles was done by Bright in 1903; in the Patagonia and Tucson quadrangles by Bright in 1903 and 1904; and in the Bisbee and Reef quadrangles by Irvine in 1901.

The stamped elevations are based upon elevations determined by the International Boundary Commission, and found later to be unreliable.

WINKELMAN QUADRANGLE.

Wooten ranch along trail via Deer Creek coal fields and Manning's ranch to Dudleyville.

	Feet.
Wooten ranch, 3.25 miles west of, in top of hard sandstone outcrop 6 feet south of trail, 10 feet northeast of 12-inch blazed pine tree, 150 feet east of point where trail crosses wash; aluminum tablet stamped "4041 PHNX"	4,040.054
Manning ranch, 2.25 miles east of, on north side of trail, 30 feet east of ravine, in top of triangular bowlder; aluminum tablet stamped "3528 PHNX"	3,526.886
Manning ranch, 1.25 miles west of, in front of 4-inch paloverde tree, 10 feet southwest of trail, in top of hard flint bowlder; aluminum tablet stamped "2998 PHNX"	2,997.229
Manning ranch, 5 miles west of, 20 feet south of trail, at west edge of gravel mound, in top of limestone bowlder; aluminum tablet stamped "2652 PHNX"	2,650.880
Manning ranch, 7.5 miles west of, on north side of trail, southwest bank of Little Rock Creek, on top of kite-shaped bowlder; aluminum tablet stamped "2510 PHNX"	2,508.617
Dudleyville, 7 miles east of, on north side of Ash Creek, at mouth of and on east side of canyon through which trail passes, in top of ledge; aluminum tablet stamped "2218 PHNX"	2,217.385
Dudleyville, 4 miles east of, on southeast side of trail, at summit of steep short ascent, 400 feet northeast of wash; iron post stamped "2418 PHNX"	2,416.751
Dudleyville, 170 feet southeast of post office, in front of guidepost in southeast corner of intersection of crossroads; iron post stamped "1950 PHNX"	1,949.118

Dudleyville southeast up San Pedro River to Pima-Pinal County line.

L. Swingle ranch house, 60 feet south of, 2 feet west of gate, north side of road; iron post stamped "1997 NOGLS"	2,008.769
Old Dodson ranch house, 0.8 mile north of, 4 feet west of road, 20 feet north of trail leading east to river; iron post stamped "2108 NOGLS"	2,119.846
Old Dodson ranch house, 1.5 miles south of, 10 feet west of road and 40 feet west of river, at toe of ridge on flint rock outcrop; painted point	2,125.84
Old Dodson ranch house, 2.5 miles south of, 50 feet north of Fort Grant Wash, in road forks; iron post stamped "2169 NOGLS"	2,180.825
Mammoth, 6.25 miles northwest of, 1,200 feet northwest of road down wash and 600 feet southeast of road forks, 8 feet west of road; iron post stamped "2295 NOGLS"	2,306.898
Mammoth, 3 miles northwest of, on spur of hill, 25 feet south of wash, 6 feet west of road; iron post stamped "2346 NOGLS"	2,358.011
Mammoth, west side of principal street, northeast corner of fence around J. E. Dubois's residence; iron post stamped "2336 NOGLS"	2,348.005

NOTE.—Between this point and Cleland ranch a constant only was added, throwing error of 0.9 foot at the Cleland ranch end of the line.

	Feet.
Mammoth, 3 miles southeast of, 10 feet east of road, foot of hill, 4 feet west of scrub mesquite tree; iron post stamped "2424 NOGLS"	2,436.020
J. L. Clark ranch house, 800 feet east of, west side of road, 2 feet south of gate entrance to ranch; iron post stamped "2466 NOGLS"	2,477.974
Acton ranch, 2.25 miles southeast of, between two buttes, on rock saddle, 15 feet southwest of road, in granite outcrop; aluminum tablet stamped "2578 NOGLS"	2,590.210
Whitlock ranch house, 1 mile southeast of, in road forks, 80 feet southeast of John Schoeyholzer's mail box; iron post stamped "2599 NOGLS"	2,610.902
Cleland ranch, 1.5 miles northwest of, 30 feet south of wash, 8 feet west of road; iron post stamped "2677 NOGLS"	2,688.915
Cleland ranch, 0.5 mile north of, east edge of road, in west side of 14-inch leaning mesquite tree; spike	2,674.08
Cleland ranch, 70 feet north of ranch house, 2 feet north of northwest corner of windmill; painted point on stone	2,672.68
Cleland ranch, 2.25 miles south of, 150 feet northwest of old adobe house on east edge of road on line between Pima and Pinal counties; iron post stamped "2703 NOGLS"	2,714.055

Point 5.5 miles north of Ben Buzzini ranch north to Oracle, thence northeast to Mammoth.

Ben Buzzini, 7.25 miles north of, east side of wash, south end of, ridge, east edge of road, 125 feet south of road forks; iron post stamped "3206 NOGLS"	3,218.061
Big Walnut ranch house, 10 feet north of, in forks of 15-inch double mesquite tree; bolt	3,303.34
Big Walnut, 1.25 miles north of, in forks Tucson and Dudleyville and Tucson and Oracle roads; iron post stamped "3399 NOGLS"	3,410.914
Big Walnut, 4.25 miles northeast of, north side of wash, 260 feet west of old road forks, 30 feet north of road, in granite bowlder outcrop; aluminum tablet stamped "3676 NOGLS"	3,688.150
Big Walnut, 7.5 miles northeast of, on north spur of ridge, 20 feet north of road forks, 4 feet above ground in conspicuous granite outcrop; aluminum tablet stamped "4040 NOGLS"	4,051.932
Oracle, 60 feet northwest of post-office building, 4 feet north of gate; iron post stamped "4502 NOGLS"	4,514.116
Armstrong ranch house, 800 feet northwest of, top of slight ridge, 135 feet north of road forks, west side of road; paint point on granite outcrop	4,247.00
Oracle, 2.8 miles northeast of, 300 feet north of main canyon, east edge of road, in granite outcrop; aluminum tablet stamped "4060 NOGLS"	4,072.022
Oracle, 5.8 miles northeast of, east side main canyon, 15 feet east of road, in mouth and in south side of small wash, in granite outcrop; aluminum tablet stamped "3653 NOGLS"	3,665.303
Shultz, 1,000 feet south of Mammoth mine, 1,000 feet west of Mohawk mine, 25 feet north of road, in granite outcrop; aluminum tablet stamped "3160 NOGLS"	3,171.640

Oracle east along highway to Cleland ranch.

	Feet.
Oracle, 3 miles east of, top of ridge, north side of road; iron post stamped "4503 NOGLS"	4,514.886
American Flag ranch house, 10 feet south of; paint point on granite outcrop	4,429.90
American Flag, 0.8 mile south of, on ridge, 50 feet north of road forks, 10 feet west of road leading to Clark mine; iron post stamped "4454 NOGLS"	4,465.917
Brady ranch, 1.25 miles southeast of, northeast point of ridge between Pepper Sauce Canyons, about 400 feet west of trail in canyon, in granite bowlder; aluminum tablet stamped "4433 NOGLS"	4,445.064
Kellogg ranch, 1.25 miles north of, 150 feet east of canyon, 2 feet east of trail, in granite bowlder; aluminum tablet stamped "4618 NOGLS"	4,630.069
Kellogg ranch, 2.25 miles east of, low gap in ridge, head of canyon leading east, 6 feet south of main canyon, 8 feet south of road, in granite outcrop; aluminum tablet stamped "3995 NOGLS"	4,007.194
Kellogg ranch, 5.25 miles east of, on flat ridge, 10 feet south of road, 50 feet north of canyon; iron post stamped "3478 NOGLS"	3,489.745
Cleland ranch, 2.8 miles west of ranch house, 200 feet north of canyon, 12 feet north of road, 10 feet west of scrub mesquite, in granite bowlder; aluminum tablet stamped "3030 NOGLS"	3,041.350

Bench mark near Dudleyville.

Dudleyville, 3 miles northwest of, near corner of wire fence, at bend, on northeast side of road; iron post stamped "1893 PHNX"	1,891.963

RED ROCK QUADRANGLE.

Red Rock north along highway to point near Florence.

Red Rock, 15 feet southeast of station, 15 feet west of railroad track, 2 feet south of telegraph pole; iron post stamped "1856 NOGLS"	1,867.229
Red Rock, in front of station; top of rail	1,867.0
Red Rock, 2.8 miles north of, in road forks; iron post stamped "1818 NOGLS"	1,829.170
Red Rock, 6.5 miles north of, 50 feet northwest of road, northeast corner of adobe hut; iron post stamped "1834 NOGLS"	1,845.084
Red Rock, 9.8 miles north of, 14 feet east of 12-inch mesquite tree, 4 feet west of road; iron post stamped "1880 NOGLS"	1,891.246
Red Rock, 13 miles north of, 4 feet west of road; iron post stamped "1915 NOGLS"	1,926.086
Paisano Tanks, 0.8 mile south of, 5 feet west of road; iron post stamped "1953 NOGLS"	1,964.204
Paisano Tanks, 200 feet west of, in signpost reading "Tucson 50 miles—Owlhead Water 20 miles"; spike	1,969.60
Paisano Tanks, 2.8 miles north of, 10 feet west of road, 4 feet south of giant cactus; iron post stamped "1909 NOGLS"	1,920.144
Paisano Tanks, 6 miles north of, 4 feet east of road, 4 feet north of 4-inch mesquite tree; iron post stamped "1751 NOGLS"	1,762.299
Paisano Tanks, 9.25 miles north of, 4 feet west of road, 6 feet south of scrub mesquite tree; iron post stamped "1669 NOGLS"	1,680.150
Florence, 3 miles south of, 6 feet east of road, 6 feet south of mesquite bush; iron post stamped "1586 NOGLS"	1,597.061

TUCSON QUADRANGLE.

Whitgoods ranch north along highway to point 5.5 miles north of Ben Buzzini ranch.

	Feet.
Benedict ranch house, 450 feet southeast of, east side of road, in west side of telephone pole; bolt	2,302.86
Benedict ranch house, 0.8 mile north of, east side of wash north-south, foot of hills, east edge of road; iron post stamped "2325 NOGLS"	2,337.096
Benedict ranch, 2.5 miles north of, 10 feet east of road, 150 feet south of road forks; paint point on bowlder outcrop	2,492.78
Benedict ranch, 4.8 miles north of, 3.5 miles south of steam pump, east edge of road; iron post stamped "2616 NOGLS"	2,627.875
T. 12 S., R. 14 E., sec. 7, Puschs steam pump, 2 feet south of northeast corner of pump house, west side of road; iron post stamped "2573 NOGLS"	2,584.942
Ben Buzzini ranch, 1 mile north of, in road forks, on ridge; iron post stamped "2835 NOGLS"	2,847.103
Ben Buzzini ranch, 4 miles north of, north end of ridge, where road enters canyon, 30 feet west of road, on east side of canyon; iron post stamped "3069 NOGLS"	3,080.857

Tucson east along highway to M. Martinez ranch, thence northwest across country to Agua Caliente ranch, thence west to Benedict ranch.

Tucson, northwest corner of Third Street and Eighth Avenue; top of hydrant	2,382.33
Tucson, University of Arizona, at east driveway entrance, 3 feet south of gate; iron post stamped "2412 NOGLS"	2,423.994
T. 14 S., R. 14 E., sec. 3, 2.3 miles east of Edmonson ranch, 5 feet south of road; iron post stamped "2473 NOGLS"	2,484.871
T. 14 S., R. 15 E., north edge of sec 6, 5.25 miles east of Edmonson ranch, 1,000 feet east of Pantano Wash, on ridge in road forks; iron post stamped "2515 NOGLS"	2,526.950
T. 14 S., R. 15 E., sec. 3, 15 feet north of William H. Bush's adobe house, 15 feet south of road; iron post stamped "2530 NOGLS"	2,542.005
Domingo Martinez ranch (near Tanque Verde), 0.8 mile southeast of, near southwest corner sec. 5, T. 14 S., R. 16 E., 1,000 feet south of schoolhouse, on ridge north side of road, at angle to east, 4 feet south of fence corner; iron post stamped "2649 NOGLS"	2,660.814
Juan Cruz ranch house, 100 feet south of, 15 feet west of gate; paint point on bowlder outcrop	2,676.19
M. Martinez ranch house, 305 feet west of, sec. 3, T. 14 S., R. 16 E., 15 feet northeast of road forks, 10 feet south of green tree, in granite outcrop; aluminum tablet stamped "2711 NOGLS"	2,722.596
Agua Caliente ranch house, 400 feet southeast of, south side of sec. 20, T. 13 S., R. 16 E., west edge of Agua Caliente Spring, in granite outcrop; aluminum tablet stamped "2728 NOGLS"	2,739.650
T. 13 S., R. 15 E., sec. 26, 3 miles west of Caliente Spring along Sabina Canyon, 0.25 mile northeast of two buttes, 8 feet south of road; iron post stamped "2635 NOGLS"	2,646.761
Corrillo ranch house, 60 feet northeast of, 70 feet west of wash, in granite bowlder; aluminum tablet stamped "2596 NOGLS"	2,607.256
Corrillo ranch, 2 miles northwest of, west side of main road at forks, northeast side of canyon; paint point on bowlder	2,741.82
Fort Lowell, 2.8 miles north of, on ridge in gap, 25 feet north of road; iron post stamped "2733 NOGLS"	2,744.570

	Feet.
Manuel Brooks ranch, 0.8 mile west of, 35 feet north of wire fence and south edge of road forks; iron post stamped "2400 NOGLS"	2,411.820

M. Martinez ranch northeast along highway to Redington.

M. Martinez ranch house, 3.25 miles northeast of, top of west spur of mountain, west edge of road, in granite outcrop; aluminum tablet stamped "3920 NOGLS"	3,931.838
Carrillo ranch house, about 900 feet northwest of, east edge of road forks of two small canyons; paint point on granite outcrop	4,094.32
Vail ranch house, about 1,000 feet west of, 500 feet south of gate at entrance to ranch, top of ridge, 8 feet west of road, in granite outcrop; aluminum tablet stamped "4284 NOGLS"	4,295.418
Vail ranch, 2.25 miles east of, top of divide, 35 feet northwest of road, in granite outcrop; aluminum tablet stamped "4340 NOGLS"	4,351.493
Youtcy ranch, 2.25 miles west of, north edge of road entrance to bed of canyon; paint point on granite bowlder	4,145.68
Youtcy ranch house, 600 feet southwest of, east edge of canyon, 8 feet east of road, in granite outcrop; aluminum tablet stamped "3851 NOGLS"	3,862.786
Youtcy ranch, 3.5 miles northeast of, on ridge 20 feet west of canyon, 3 feet east of road; iron post stamped "3573 NOGLS"	3,584.662

Tucson south along highway to southeast corner of Papago Indian Reservation.

Tucson, in front of Southern Pacific R. R. station; top of south rail	2,388.0
Tucson, corner West Sixth and North Court Streets; top of hydrant	2,359.10
Tucson, south wall of Pima County courthouse, 11 feet west of south entrance in fourth foundation stone from ground; bronze tablet stamped "2364 NOGLS"	2,376.049
Tucson, 1.8 miles south of courthouse, 0.5 mile east of river, 150 feet east of river bottom at south end of Osborne Avenue at angle to west, 3 feet west of gate entrance to A. Duravo's pasture; iron post stamped "2376 NOGLS"	2,388.368
Tucson, 4.25 miles south of, 0.25 mile east of river, at junction of seven roads, 6 feet east of southeast fence corner; iron post stamped "2434 NOGLS"	2,446.088
Tucson, 6.5 miles south of, 600 feet west of river, 15 feet west of northwest fence corner at angle of road; iron post stamped "2452 NOGLS"	2,464.017
Tucson, 8 miles south of, in south gatepost at entrance to inclosure on Papago Reservation adobe settlement; spike	2,498.18
Tucson, 9.5 miles south of, 0.5 mile south of Sahuarito Butte, on ridge, 275 feet east of river bottom, 50 feet west of wire fence, 2 feet south of mesquite tree, in road forks; iron post stamped "2540 NOGLS"	2,551.912
Hart ranch, 6.25 miles north of, 10 feet east of road, 1 foot north of telephone pole; iron post stamped "2594 NOGLS"	2,606.127
Hart ranch, 3.5 miles north of, south side of flat draw, 100 feet west of road, 175 feet southeast of adobe house, 1 foot north of telephone pole; iron post stamped "2630 NOGLS"	2,642.200

Vail southwest 3 miles.

	Feet.
Vail, 220 feet northeast of station, 5 feet east of gate; iron post stamped "3220"	3,232.479
Vail, 2.8 miles south of, crossing of Andrade-Tucson and Vail-Helvetia roads, southwest side; iron post stamped "3290 NOGLS"	3,302.681

Vail southeast 3 miles.

Vail, 1 mile southeast of, west edge of road, 150 feet south of road forks; paint point on bowlder outcrop	3,274.14
Vail, 2 miles southeast of, 200 feet east of old road forks, 8 feet north of road; paint point on bowlder outcrop	3,352.87
Vail, 3 miles southeast of, 20 feet west of road; paint point on stone	3,439.72

Tucson west along highways to Carnegie Botanical Laboratory.

Tucson, 1.9 miles west of, 20 feet south of forks, 800 feet east of hospital, west side of road; cross on rock	2,352.46
Tucson, 2.8 miles west of, at Carnegie Botanical Laboratory, 10 feet north of east entrance, near northeast corner of building; aluminum tablet stamped "2363 1907"	2,673.865

DRAGOON QUADRANGLE.

Pima-Pinal county line south along highway to point near Benson.

Redington, 3.25 miles north of, 100 feet west of angle in road to south, 6 feet west of scrub mesquite tree, 4 feet north of road; iron post stamped "2788 NOGLS"	2,799.097
Redington, 45 feet south of post office, in granite bowlder outcrop; aluminum tablet stamped "2869 NOGLS"	2,880.103
Redington, 4 miles southeast of, north side of flat ridge, north side main road, 60 feet east of road forks; iron post stamped "2994 NOGLS"	3,005.050
San Antonio Church, 2 feet east of southeast corner; iron post stamped "3018 NOGLS"	3,029.046
Antonio Soso ranch house, 800 feet north of, west edge of road forks, 1 foot east of corner post at angle in fence; iron post stamped "3057 NOGLS"	3,068.093
J. L. Story ranch house, 1,600 feet west of, entrance to ranch, 600 feet east of road forks, in south gate post; spike	3,146.95
Pool post office and ranch house, 400 feet northeast of, 2 feet east of scrub mesquite tree, 6 feet west of road forks; iron post stamped "3158.5 NOGLS"	3,169.561
Mercedes Lopez ranch house, 300 feet east of, top of ridge, east side of road forks; iron post stamped "3200 NOGLS"	3,211.009
Boone ranch, 0.5 miles south of, 150 feet east of river, 50 feet east of irrigation ditch, east side of road forks, west end of ridge at angle in road to east; iron post stamped "3216 NOGLS"	3,226.909
George Etz ranch house, 900 feet northwest of, 2 feet west of south gate post entrance to ranch; iron post stamped "3263 NOGLS"	3,273.996
George Etz ranch, 2.8 miles south of, on spur of hill, 6 feet west of road in hills, about 600 feet north of angle in road to west up wash; iron post stamped "3372 NOGLS"	3,382.995

	Feet.
George Etz ranch, 5.8 miles south of, 10 feet east of road, 2 feet southwest of 10-inch leaning mesquite tree utilized as fence corner post; iron post stamped "3402 NOGLS"	3,413.002
T. 15 S., on line between Rs. 19 and 20 E., 850 feet east of section corner, east side of road at forks; iron post stamped "3435 NOGLS"	3,445.942
Marcos Pachico ranch, 1.5 miles southeast of, on point of ridge at south edge of river bottom, south side of irrigation ditch, 2 feet south of fence corner post; iron post stamped "3443 NOGLS"	3,453.941

Point 2 miles southeast of Redington southwest 3.5 miles.

Moraga ranch, about 0.3 mile north of, 250 feet west of river bottom, west end of lane, south side of road forks, at intersection of wire and brush fence, 3 feet east of mesquite tree 12 inches in diameter, 4 feet north of three 13-inch mesquite trees; iron post stamped "2899 NOGLS"	2,910.649

PATAGONIA QUADRANGLE.

Point 3.2 miles north of Marsh & Driscoll ranch north to southeast corner Papago Indian Reservation.

Marsh & Driscoll ranch, 5.25 miles north of, 12 feet east of road, 2 feet north of 10-inch mesquite tree; iron post stamped "2874 NOGLS"	2,886.125
S. E. Brown ranch house, 270 feet west of, 12 feet east of road, 1 foot north of mail box post; iron post stamped "2783 NOGLS"	2,795.191
S. E. Brown ranch, 3 miles north of, 9 feet west of road, 2 feet south of 10-inch mesquite tree; iron post stamped "2715 NOGLS"	2,727.225
Hart ranch, point on top of south concrete wall around small reservoir, 65 feet east of road	2,689.58
Hart ranch, 0.5 mile north of, on open flat, in road forks; iron post stamped "2665 NOGLS"	2,677.099

Point 3 miles southwest of Vail southwest 21 miles to south gate of United States Botanical Range Reserve, thence northwest to sec. 7, T. 17 S., R. 14 E.

Ts. 16 and 17 S., Rs. 15 and 16 E., 2 feet north of stone corner of townships; iron post stamped "3237 NOGLS"	3,249.481
Vail, 5.5 miles south of, 75 feet south of road forks, in south side of double paloverde tree, south side of wash; iron bolt	3,334.24
Stone ranch, 3.5 miles north of, foot of mesa, in road forks; iron post stamped "3323 NOGLS"	3,335.513
Stone ranch house, 250 feet northwest of, in road forks, on west slope of ridge; iron post stamped "3824 NOGLS"	3,836.556
Neff & Buckobus ranch house, 40 feet west of, in top of post at northeast corner of Bessie mine location; nail	3,901.08
Helvetia, 0.5 mile west of, south side of canyon, in road forks; iron post stamped "4173 NOGLS"	4,185.318
Proctor ranch house, 600 feet north of, on north side of Box Canyon; iron post stamped "4267 NOGLS"	4,279.431
Proctor old ranch, 2.8 miles south of, 90 feet south of Sawmill Canyon, 145 feet west of fence corner at angle to northwest, 2 feet north of fence; iron post stamped "3969 NOGLS"	3,981.410
United States botanical reserve, 3 feet east of south gate; iron post stamped "3721 NOGLS"	3,733.518

	Feet.
United States botanical reserve, south gate in fence, 3.8 miles north of, 4 feet west of road and 4 feet east of 12-inch leaning mesquite tree; iron post stamped "3386 NOGLS"	3,398.473
United States botanical reserve, north gate in fence, 1.25 miles south of, west edge of road, south side of spreading paloverde tree; iron post stamped "2963 NOGLS"	2,975.451
United States botanical reserve, north gate in fence, in east gate post; spike	2,880.42
Hart ranch, 3.8 miles south of, 4 feet west of road, 8 feet east of 8-inch mesquite tree, 200 feet north of angle in road to northwest; iron post stamped "2800 NOGLS"	2,812.423
Point 3 miles southeast of Vail southeast along highways to Andrade ranch, thence southwest to point near Greaterville, thence east to Empire ranch, thence northeast to Sanford ranch, thence north to Pantano.	
Vail, 4 miles southeast of, on ridge, 5 feet west of road; iron post stamped "3531 NOGLS"	3,543.540
Vail, 6.25 miles southeast of, 215 feet southeast of road fork, 12 feet west of road, in granite outcrop; aluminum tablet stamped "3711 NOGLS"	3,723.362
Andrade ranch house, 200 feet west of, in granite outcrop; aluminum tablet stamped "3745 NOGLS"	3,756.933
Andrade ranch, 4.25 miles south of, crossing of road and wash, east side in point of conglomerated rock bluff; bronze tablet stamped "4079 NOGLS"	4,091.466
Rosemont, 1.8 miles northeast of, 500 feet west of road forks, south point of ridge, 65 feet east of wash, 12 feet north of road, 3 feet south of double mesquite tree, in granite outcrop; bronze tablet stamped "4534 NOGLS"	4,546.278
Rosemont, 400 feet north of schoolhouse, in road forks, in south side of 20-inch Spanish oak tree; spike	4,780.53
Rosemont, 2.5 miles south of, head of Box Canyon, in gap at top of ridge, 2 feet west of road; iron post stamped "5164 NOGLS"	5,176.268
Empire ranch, 3.8 miles west of, north side of wash, about 150 feet south of hills, 20 feet north of road; iron post stamped "4900 NOGLS"	4,912.472
Empire ranch house, 0.25 mile south of, west side of road forks, 10 feet north of 12-inch mesquite tree utilized as fence corner post; iron post stamped "4632 NOGLS"	4,644.158
Empire ranch, 4.25 miles north of, on slight ridge, 10 feet east of road, 6 feet north of gate; iron post stamped "4320 NOGLS"	4,332.222
Sanford old ranch house, 20 feet east of, east edge of road on fence line, in west side of 20-inch dead tree; staple	4,212.103
Sanford ranch, 1 mile north of, in gap at top of ridge, north edge of road; iron post stamped "4316 NOGLS"	4,328.180
Total Wreck, 700 feet north of, 20 feet east of road in gap; paint point on rock	4,574.97
Total Wreck, 1.5 miles northwest of, west side of canyon, 6 feet west of road, in granite outcrop; aluminum tablet stamped "4306 NOGLS"	4,318.223
Pantano, 3.25 miles south of, on ridge, 23 feet east of road, in granite bowlder outcrop; aluminum tablet stamped "3836 NOGLS"	3,848.505

	Feet.
Pantano, 400 feet northeast of station, 12 feet east of warehouse, south side of road near plank fence; iron post stamped "3540 NOGLS"	3,552.074
Pantano, in front of station; top of north rail	3,546.6

Empire ranch southeast along highways to Elgin.

Cottonwood, 1 mile east of, 3 feet south of road, east slope of hill, west side of draw; iron post stamped "4529 NOGLS"	4,541.170
Elgin, 4.5 miles northwest of, 80 feet south of road forks, 4 feet east of road, in granite outcrop; bronze tablet stamped "4926 NOGLS"	4,937.809

Elgin west and southwest along Southern Pacific R. R. to point near Sanford siding.

Elgin, 45 feet south of track, northwest corner of yard fence around section house; iron post stamped "4706 NOGLS"	4,718.060
Elgin, 3.25 miles west of, 50 feet south of track, top of cut near wire fence; iron post stamped "4835 NOGLS"	4,847.158
Sonoita, 1.5 miles east of, 210 feet southeast of milepost 1079, 50 feet south of track, near wire fence; iron post stamped "4777 NOGLS"	4,789.068
Sonoita, 0.5 miles west of, 0.25 mile west of milepost 1081, in west end of north guard rail of bridge A; second bolt	4,818.26
Sonoita, 1.5 miles west of, at public road crossing, 45 feet west of track; iron post stamped "4746 NOGLS"	4,758.143
Milepost 1085, 0.25 mile west of, on bolt in south end of east cap of bridge B	4,549.75
Sonoita, 5 miles southwest of, between mileposts 1085 and 1086, point of ridge, 50 feet east of railroad, at curve D 10–No. 77, near wire fence, in lime rock; aluminum tablet stamped "4512 NOGLS"	4,524.677
Crittenden, 1.5 miles north of, 240 feet south of milepost 1089, at public road crossing, 45 feet west of track; iron post stamped "4263 NOGLS"	4,274.898
Crittenden, 200 feet south of station, 12 feet west of track, 1 foot east of southeast foundation stone under water tank; point on granite outcrop	4,193.16
Patagonia, 1.5 miles northeast of, in north end of west guard rail of bridge A; bolt	4,116.84
Patagonia, 100 feet east of station, 16 feet north of track; iron post stamped "4044 NOGLS"	4,056.304
Milepost 1096, 20 feet north of, east end of steel bridge over Sonoita River, 5 feet south of track; point on stone wall	3,949.34
Milepost 1097, 200 feet east of, east end of steel bridge over Sonoita River, 5 feet south of track, in stone wall; aluminum tablet stamped "3891 NOGLS"	3,903.076
Sanford, 1.8 miles east of, 4 feet north of track, point on stone wall at east end of steel bridge over Sonoita River	3,819.84
Sanford, 1 mile east of, 2,100 feet east of milepost 1100, 120 feet east of bridge B, 8 feet north of track, in rock ledge; aluminum tablet stamped "3785 NOGLS"	3,797.070

Patagonia southeast along highways 4 miles.

Patagonia, 3 miles southeast of, 100 feet south of road forks, 10 feet west of road; iron post stamped "4223 NOGLS"	4,235.112

Point 8.5 miles north of Calabasas and 3 miles east of Santa Cruz River east along highway to steam pump, thence southeast to Southern Pacific R. R.

	Feet.
Santa Cruz, 3 miles east of, on flat ridge, 35 feet south of road, in blue lime rock outcrop; aluminum tablet stamped "3645 NOGLS"	3,657.181
Santa Cruz, 6.25 miles east of, in gap at head of canyon, 30 feet west of road, in granite rock; aluminum tablet stamped "3948 NOGLS"	3,959.818
Salero steam pump, 0.8 mile west of, 700 feet north of old adobe houses, 200 feet east of canyon, 25 feet east of road, in lime rock outcrop; aluminum tablet stamped "4127 NOGLS"	4,138.713
Salero steam pump, 2.5 miles southeast of, top of ridge, 25 feet west of road; iron post stamped "4498 NOGLS"	4,509.715
Salero steam pump, 4.5 miles southeast of, 40 feet east of draw, 10 feet west of road; iron post stamped "4360 NOGLS"	4,372.159

Canelo Pass north to Boyle ranch, thence east to point near Evans schoolhouse.

Boyle ranch house, 500 feet southeast of, 120 feet east of road forks, at fence corner; iron post stamped "5034 NOGLS"	5,046.601

ARIVACA QUADRANGLE.

Point 3 miles northwest of Calabasas north to point 2 miles north of Marsh & Driscoll ranch.

Calabasas, 5.5 miles north of, west side of road, 3 feet north of gate entrance to Ohms ranch; iron post stamped "3321 NOGLS"	3,333.201
Calabasas, 8.5 miles north of, in forks of road; iron post stamped "3279 NOGLS"	3,291.397
Tubac, 1 mile south of, 75 feet west of road forks, at southeast corner of adobe house; iron post stamped "3222 NOGLS"	3,234.486
Tubac, 2.25 miles north of, 7 feet east of road, 2 feet south of 18-inch leaning mesquite tree at angle in road to northwest; iron post stamped "3140 NOGLS"	3,152.156
Tubac, 5.5 miles north of, 10 feet east of road, on slight ridge; iron post stamped "3096 NOGLS"	3,108.280
The Junction, 1,500 feet south of, 75 feet east of ridge, 15 feet east of road, 1 foot north of fence; iron post stamped "3038 NOGLS"	3,049.932
L. A. Smith ranch house, 2.8 miles north of, 6 feet west of road, 1 foot south of telephone pole; iron post stamped "2949 NOGLS"	2,961.129
Marsh & Driscoll ranch, 2 miles north of, 40 feet east of main road, 20 feet west of loop in road, 1 foot southeast of telephone pole; iron post stamped "2909 NOGLS"	2,921.134

Point 8.5 miles north of Calabasas east 2 miles.

Calabasas, 8.5 miles north of, in road forks, east side of river, 25 feet east of Tucson and Nogales public road; iron post stamped "3279 NOGLS"	3,291.397

NOGALES QUADRANGLE.

Nogales north along Southern Pacific R. R. to Calabasas; thence northeast to Sanford siding.

Nogales, International boundary monument 122; northeast corner of masonry base	3,863.57
Nogales, 1 mile north of, 200 feet north of milepost 1119, in north end of west guard rail to bridge A; bolt	3,824.70

	Feet.
Nogales, 3 miles north of, 700 feet north of milepost 1117, west side of road, 75 feet east of Maraposa ranch house; iron post stamped "3734 NOGLS"	3,746.245
Nogales, 5 miles north of, 100 feet south of milepost 1115, in north end of east guard rail to bridge A; bolt	3,662.30
Nogales, 6 miles north of, 50 feet west of track, 10 feet north of gate, 500 feet south of milepost 1114; iron post stamped "3598 NOGLS"	3,610.294
Calabasas, 60 feet north of station, 2 feet east of gate; iron post stamped "3433 NOGLS"	3,445.411
Calabasas, 2.8 miles east of, east end of iron bridge over Sonoita River, north side of track, in top of stone wall; aluminum tablet stamped "3507 NOGLS"	3,519.356
Milepost 1105, 400 feet west of; bolt in east end of south guard rail of bridge A	3,586.03
Walnut Grove ranch, 0.5 mile east of, east end of steel bridge over Sonoita River, north side of track, in top of stone wall; aluminum tablet stamped "3641 NOGLS"	3,653.675
Milepost 1103, 0.25 mile west of, on bolt in north end of steel cap on east end of bridge over Sonoita River	3,688.64

Calabasas northwest along highway 2.5 miles.

Calabasas, 2.5 miles north of, at road forks, 2 feet west of northwest fence corner; iron post stamped "3377 NOGLS"	3,389.139

Point near Nogales from monument 122 east along international boundary to monument 119. (See also connection at Lochiel at monument 112.)

Post 122, Nogales, top of masonry base (Boundary Commission elevation 3,851.37)	3,863.57
Post 121, Nogales (Boundary Commission elevation 3,995.40)	4,016.14
Post 120 (Boundary Commission elevation 4173.55)	4,192.58
Post 119 (Boundary Commission elevation 4095.47)	4,101.71

Point 4 miles southeast of Patagonia southeast along highway to Lochiel.

A. B. Sorrell ranch house, 500 feet east of, 75 feet east of road, in igneous rock outcrop; aluminum tablet stamped "4653 NOGLS"	4,465.998
Hardshell store, 125 feet northwest of, 4 feet west of road; point on limestone rock	4,964.68
Hardshell store, 1.8 miles south of, 25 feet east of road, on side of hill, in limestone outcrop; aluminum tablet stamped "5241 NOGLS"	5,253.642
Moury Mines, 2 feet south of road, 20 feet north of well, in 8-inch Spanish oak tree; nail	5,415.66
Moury Mines, 0.7 mile south of, 400 feet northeast of adobe house, 16 feet north of road, 5 feet north of Spanish oak tree 22 inches in diameter, in quartz rock; aluminum tablet stamped "5394 NOGLS"	5,406.361
Washington, 0.2 mile north of, 15 feet east of road forks, on top of ridge; iron post stamped "5496 NOGLS"	5,508.121
Washington, 2.5 miles east of, on narrow ridge, 2 feet south of road, in lime rock outcrop; aluminum tablet stamped "5021 NOGLS"	5,033.114
Lochiel, north side of road, in front of Chinese store, in post; spike	4,686.54

Lochiel northeast along highway to Canelo Pass.

	Feet.
International boundary iron post 112, top of masonry base (Boundary Commission elevation 4,760.49)	4,776.095
Cameron ranch, 1.5 miles north of, top of ridge, 85 feet east of road, 75 feet west of wire fence, in lime rock; aluminum tablet stamped "4830 NOGLS"	4,842.299
Little ranch house, 1 mile north of, top of north-south ridge, 15 feet southeast of road; iron post stamped "4997 NOGLS"	5,009.497
Canelo Pass, 100 feet south of top in divide, 15 feet west of road, in granite outcrop; aluminum tablet stamped "5442 NOGLS"	5,454.630

BENSON QUADRANGLE.

Benson north to Boquilla Cattle Co. ranch.

Boquilla Cattle Co. ranch house, 800 feet west of, 200 feet southwest of flat-top butte, east side of road forks, 1 foot west of fence corner post; iron post stamped "3500 NOGLS"	3,511.008

Benson south along El Paso & Southwestern R. R. to Fairbank.

Benson, in front of passenger station; top of south rail	3,580.3
Benson, intersection of Huachuca and Fourth streets, northwest corner of Virginia Hotel; iron post stamped "3573 NOGLS"	3,583.942
Benson, 3 miles southeast of, 100 feet west of track, 20 feet west of milepost 1034; iron post stamped "3541 NOGLS"	3,551.929
Ts. 17 and 18 S., Rs. 20 and 21 E., corner of townships, 150 feet east of El Paso & Southwestern R. R. and 60 feet west of Southern Pacific R. R., east side of wagon road between crossings; iron post stamped "3583 NOGLS"	3,594.996
Lands Crossing, 200 feet southeast of milepost 1040, 50 feet east of railroad track, 1 foot north of fence corner post; iron post stamped "3644 NOGLS"	3,654.863
Lands Crossing, 3.25 miles south of, 0.25 mile south of milepost 1043, 45 feet east of El Paso & Southwestern R. R., 50 feet west of Southern Pacific R. R., east edge of wagon road, 3 feet southeast of telegraph pole; iron post stamped "3707 NOGLS"	3,717.906
Fairbank, 3.25 mile north of, 100 feet southwest of public road crossing, 50 feet west of track, 60 feet south of road forks, east side of road, 70 feet east of irrigation ditch, 2 feet south of fence corner post; iron post stamped "3780 NOGLS"	3,790.886
Fairbank, Southern Pacific R. R. track; top of rail	3,852.0

Evans school east and northeast along highway to Tombstone.

Evans schoolhouse, 2 feet south of east entrance, 4 inches above ground, in foundation stone; aluminum tablet stamped "4927 NOGLS"	4,939.271
Pyeatts ranch house, 150 feet south of, 45 feet south of road, in limestone outcrop; aluminum tablet stamped "5185 NOGLS"	5,197.464
Pyeatts ranch, 3 miles east of, east side of slope, 30 feet north of road; iron post stamped "5061 NOGLS"	5,073.479
Fort Huachuca, 2 feet northeast of wagon scales, 18 feet north of commissary; iron post stamped "5046 NOGLS"	5,058.429

	Feet.
O. R. ranch house, in foundation stone of south wall at southeast corner; aluminum tablet stamped "4605 NOGLS"	4,617.393
O. R. ranch, 3.5 miles east of, 150 feet north of road, 1 foot south of quarter corner between secs. 25 and 30, T. 21 S., Rs. 20 and 21 E.; iron post stamped "4424 NOGLS"	4,436.252
O. R. ranch, 6.8 miles northeast of, 2 feet north of road, opposite large mesquite tree in wash 500 feet south; iron post stamped "4232 NOGLS"	4,244.432
Charleston, 20 feet east of El Paso & Southwestern R. R. track, 20 feet south of wagon road at crossing; iron post stamped "3957 NOGLS"	3,969.465
Charleston, 3.25 miles northeast of, top of ridge, 12 feet south of road; iron post stamped "4240 NOGLS"	4,252.415
Tombstone, 2.25 miles southwest of, north side of hill, 40 feet south of road, in limestone outcrop; aluminum tablet stamped "4534 NOGLS"	4,546.295
Tombstone, in north wall of county courthouse, 4 feet east of north entrance; aluminum tablet stamped "4526 NOGLS"	4,538.259

Tombstone west along El Paso & Southwestern and Southern Pacific R. Rs. to point near Elgin.

Tombstone, 3 miles west of, 300 feet west of trestle over Tombstone Gulch, 23 feet south of railroad track, in granite outcrop; bronze tablet stamped "4200 NOGLS"	4,212.257
Fairbank, 2.25 miles east of, 150 feet west of wagon road under trestle, 40 feet north of railroad, top of cut; iron post stamped "4016 NOGLS"	4,028.255
Fairbank, 1 mile east of, 365 feet west of public road crossing, in east end of north guard rail of bridge; on bolt	3,924.90
Fairbank, north side of street, 15 feet east of street corner, in front of Montezuma Hotel; iron post stamped "3847 NOGLS"	3,858.370
Fairbank, 3 miles west of, 680 feet west of milepost 1053, 40 feet west of iron bridge, 12 feet north of track, top of south wall of canyon, in granite rock; aluminum tablet stamped "3973 NOGLS"	3,985.587
Milepost 1054, 1,000 feet west of, in east end of south guard rail to bridge A; on bolt	4,040.03
Brookline, 0.8 mile west of, midway between milepost 1056 and 1057, at public road crossing, 15 feet north of track, east side of wagon road; iron post stamped "4111 NOGLS"	4,122.199
Huachuca, 1,480 feet east of station, 50 feet north of track, at fence corner; iron post stamped "4253 NOGLS"	4,265.296
Huachuca, in front of station; top of north rail	4.281.0
Huachuca, 3.25 miles west of, at old adobe town, 150 feet north of track, 2 feet south of gate and right of way fence; iron post stamped "4406 NOGLS"	4,418.322
Huachuca, 5 miles west of, in northwest corner of iron bridge; at milepost 1066; on bolt	4,487.58
Huachuca, 6 miles west of, 50 feet north of track, 50 feet east of milepost 1067; iron post stamped "4522 NOGLS"	4,534.292
Elgin, 2.8 miles east of, 35 feet south of track and road crossing, west edge of wagon road, at fence corner; iron post stamped "4617 NOGLS"	4,629.180

Charleston south along El Paso & Southwestern R. R. to point near Banning switch and return.

	Feet.
Charleston, 20 feet east of track, 20 feet north of road crossing; iron post stamped "3957 NOGLS"	3,969.465
Culvert 2668, 600 feet east of, 600 feet east of Huachuca pipe line, 3 feet east of gate, in rock; aluminum tablet stamped "4000 NOGLS"	4,012.090
Lewis Springs, west wall of pump house; aluminum tablet stamped "4019 NOGLS"	4,030.887
Lewis Springs, 3.5 miles south of, 200 feet southeast of cut, 100 feet south of old roadbed, in rock; aluminum tablet stamped "4194 NOGLS"	4,206.344
Lewis Springs, 6.7 miles south of, 40 feet north of old roadbed, 550 feet west of large wash, in rock; aluminum tablet stamped "4359 NOGLS"	4,370.957
Banning switch, 1.5 miles south of, 0.25 mile south of bridge 90, 50 feet north of old roadbed; iron post stamped "4368 NOGLS"	4,380.341

Point near Banning switch west to point near Robinson ranch.

Banning switch, 2 miles north of, 40 feet south of road; chisel mark on sunken bowlder; mesquite tree near bowlder marked "U. S. G. S. B. M. 4520"	4,532.69
Robinson ranch, 1.4 miles west of, south of forks in road 15 feet, in granite bowlder 2 by 3 feet; bronze tablet stamped "4702 M. P. 92"	4,715.255
Robinson ranch, 100 yards south of house, 2 feet east of south gate post; chisel mark on stone; post marked "U. S. G. S. B. M. 4811"	4,823.81

REEF QUADRANGLE.

Point near Banning switch southeast along El Paso & Southwestern R. R. to Naco Junction.

Packard, 3 miles north of, 390 feet north of bridge 94, 40 feet east of railroad, in lime bowlder; bronze tablet stamped "4489 M. P. 92"	4,502.021
Packard, 100 feet east of platform of station, 50 feet east of track, 150 feet east of railroad crossing, south end of switch; iron post stamped "4666 M. P. 92"	4,678.969

BISBEE 15′ QUADRANGLE.

International boundary monument 92 northeast along road to Don Luis, thence via El Paso & Southwestern R. R. to Bisbee, thence north-northeast and south along trail via Brewery Gulch and Sulphur Springs Valley Road to International boundary monument 88.

Naco, 0.5 mile east of, International boundary monument 92, top of masonry corner	4,603.395
Naco, 0.5 mile north of, 60 feet north of large signboard, at forks of wagon road to Naco; iron post stamped "4538 M. P. 92"	4,551.566
Hull's Halfway House, 1 mile south of, at road crossing, 20 feet east of main road to Naco; iron post stamped "4868 M. P. 92"	4,881.331
Bisbee, 2.2 miles south of, railroad crossing at forks of roads, 10 feet west of railroad, 40 feet west of Bisbee-Naco Road; bronze tablet stamped "5166 M. P. 92"	5,178.865

	Feet.
Bisbee, Copper Queen Mining Co.'s store building, in northwest corner; bronze tablet stamped "5300 M. P. 92"	5,313.208
Bisbee, 0.7 mile north of Copper Queen Mining Co.'s store, in Brewery Gulch, north of road, in front of house No. 7, point of ledge; bronze tablet stamped "5383 M. P. 92"	5,396.096
Bisbee, 1.7 miles north of, divide between Bisbee and Sulphur Springs Valley and forks of trail, in conglomerate projecting ledge; bronze tablet stamped "5939 M. P. 92"	5,952.159
Forest ranch, 6.5 miles north of, forks of Sulphur Springs Valley-Dixie Canyon wagon road, 1.5 miles north of main road; iron post stamped "4272 M. P. 92"	4,285.179
Forest ranch, 2.5 miles northeast of, 20 feet north of road to Wilcox, north side of big wash; iron post stamped "4357 M. P. 92"	4,370.209
Forest ranch, 3 miles south of, road to Slaughter ranch, 20 feet west of, and west of wash; iron post stamped "4354 M. P. 92"	4,366.998
Forest ranch, 6.5 miles south of, 0.25 mile north of lone buttes on flat, 10 feet east of road; iron post stamped "4284 M. P. 92"	4,296.947
Forest switch, 0.25 mile southwest of, 600 feet south of railroad, northeast corner of Slaughter ranch fence; iron post stamped "4237 M. P. 92"	4,250.011
Slaughter ranch, 1 mile south of, International monument 88, top of masonry	4,330.095

Bisbee west along Tombstone Road to point on El Paso & Southwestern R. R. 1.5 miles south of Banning switch, thence southeast via railroad to permanent bench mark 0.5 mile north of Naco.

Bisbee, 2.8 miles west of, divide between Tombstone and Bisbee, forks of wagon road, 60 feet north of main road to Tombstone, projection of quartz ledge; bronze tablet stamped "6038 M. P. 92"	6,050.773
Cox ranch, 100 feet west of house, 12 feet north of wagon road, 50 feet north of corner of stone corral, granite bowlder 2 feet out of ground; bronze tablet stamped "5094 M. P. 92"	5,107.221
Naco Junction, 60 feet southwest of platform, between wagon road and railroad; iron post stamped "4674 M. P. 92"	4,687.108

Bisbee south by road via Holbrook, Calumet and Arizona, Lowell, and Bisbee West mines to Don Luis.

Calumet & Arizona mine, "Irish Mag" shaft, 200 feet northeast of, 50 feet west of lime house and 10 feet west of road, in limestone ledge; aluminum tablet stamped "5540 M. P. 92"	5,552.995
Gardner mine, 200 feet south of shaft, summit of divide between Gardner and Lowell, 10 feet east of wagon road, in limestone rock; aluminum tablet stamped "5373 M. P. 92"	5,386.322
Lowell mine, 1,000 feet south of shaft, summit of divide between Lowell and South Bisbee, 5 feet west of trail, in projection of limestone ledge; aluminum tablet stamped "5431 M. P. 92"	5,443.938
Bisbee West mine, 60 feet west of office and 90 feet north of wagon road, in projection of granite ledge; aluminum tablet stamped "5399 M. P. 92"	5,411.850

Chiricahua, Cochise, Pearce, and San Simon Quadrangles (Chiricahua National Forest).

COCHISE COUNTY.

The elevations in the following list are based upon the precise-level line along the Southern Pacific Railroad as corrected in 1907. For additional elevations in the Cochise and San Simon quadrangles refer to precise-level list, pages 13–14. Additional elevations in the San Simon and Chiricahua quadrangles are given in list for New Mexico (Bulletin 464). The line from Cochise via Pearce and Shaw ranch to a point near Apache Pass is not finally adjusted. It closed 3.5 feet low, and assuming that a yard error was made in rod reading, that amount has been thrown at end of line near Apache Pass and the fraction 0.5 foot adjusted.

The leveling in the Pearce quadrangle was done by Chester Irvine in 1901 and by T. A. Green in 1907. The leveling in the three remaining quadrangles was done by Green in 1907.

SAN SIMON QUADRANGLE.

Bowie south along road to mouth of canyon 4.7 miles north of Apache Pass, thence northeast to San Simon.

	Feet.
Bowie, southeast corner of Solomon & Wickersham's store; iron post stamped "3748 H 111–1907"	3,758.956
Bowie, 3.41 miles south of, 15 feet west of road; iron post stamped "3817 1907"	3,827.943
Bowie, 6.44 miles south of, 50 feet east of road; iron post stamped "3930 1907"	3,940.348
Bowie, 9.21 miles south of, 10 feet east of road; iron post stamped "4167 1907"	4,177.785
Apache Pass, 5.01 miles northeast of, 1,400 feet east of mouth of canyon, south side of wagon road; aluminum tablet stamped "4453 1907"	4,464.139
Apache Pass, 8.01 miles northeast of, 1.24 miles northeast of T. J. Rigg ranch, west side of road, just south of stream crossing; iron post stamped "4303 1907"	4,314.348
Apache Pass, 10.81 miles northeast of, 4.04 miles northeast of T. J. Rigg ranch, west side of road; iron post stamped "4027 1907"	4,038.006
Apache Pass, 14 miles northeast of, 7.23 miles northeast of T. J. Rigg ranch, west side of road; iron post stamped "3810 1907"	3,821.168
Apache Pass, 16.81 miles northeast of, 10.04 miles northeast of T. J. Riggs ranch, west side of road; iron post stamped "3665 1907"	3,675.664
San Simon, 75 feet north of track, 100 feet west of station; iron post stamped "3601"	3,611.340
San Simon, 558 feet north of track, 700 feet northwest of station, in rock, San Simon triangulation station; aluminum tablet stamped "3598"	3,610.316

San Simon south along road to Eagle City, thence east to Cienaga, N. Mex.

San Simon, 2.82 miles south of, 30 feet east of road; iron post stamped "3641 1907"	3,651.678

	Feet.
San Simon, 5.6 miles south of, 100 feet south of dry stream crossing, 10 feet west of road; iron post stamped "3753 1907"	3,764.342
San Simon, 8.78 miles south of, 10 feet east of road; iron post stamped "3888 1907"	3,898.922
San Simon, 11.37 miles south of, 8 feet west of road, in large rock beside rock monument; aluminum tablet stamped "4074 1907"	4,085.278
San Simon, 14.25 miles south of, 5 feet west of road; iron post stamped "4260 1907"	4,270.889
San Simon, 16.72 miles south of, 1 mile northeast of Eagle City, 5 feet east of road, in large rock just south of rock monument; aluminum tablet stamped "4454 1907"	4,464.404
Eagle City, 1.5 miles east of, west side of road at forks; iron post stamped "4574 1907"	4,584.470
Eagle City, 5.38 miles northeast of, 8 feet north of road; iron post stamped "4229 1907"	4,240.339
Eagle City, 8.20 miles northeast of, 10 feet south of road; iron post stamped "4027 1907"	4,037.935

Paramors ranch northwest to San Simon.

Cienaga, 3.06 miles north of, 0.56 mile north of Paramores ranch, 10 feet west of road; iron post stamped "3868 1907"	3,879.036
Cienaga, 6.32 miles northwest of, 3.82 miles northwest of Paramores ranch, 5 feet west of road, 75 feet east of San Simon River, in rock; aluminum tablet stamped "3796 1907"	3,806.839
Cienaga, 9.39 miles northwest of, 0.96 mile northwest of large adobe corral, 40 feet west of mesquite bush, 20 feet east of road, in rock; aluminum tablet stamped "3744 1907"	3,754.482
Cienaga, 13.25 miles northwest of, 9.75 miles northwest of Paramores ranch, 3.82 miles northwest of large adobe corral, 10 feet east of road; iron post stamped "3699 1907"	3,710.056
San Simon, 5.6 miles southeast of, 16.64 miles northwest of Cienaga, 7.21 miles northwest of large adobe corral, 13.14 miles northwest of Paramores ranch, 10 feet east of road; iron post stamped "3647 1907"	3,657.762
San Simon, 3.1 miles southeast of, 19.12 miles northwest of Cienaga, 75 feet northeast of northeast corner of old adobe ruin, 40 feet west of road, in large rock; aluminum tablet stamped "3616 1907"	3,627.222

Bench mark 3.4 miles north of Shaw ranch north to Apache Pass and Canyon 4.7 miles north of pass.[1]

Shaw ranch, 3.39 miles northwest of, on west side of wagon road, 40 feet north of fence corner; iron post stamped "4990 1907"	5,002.151
Shaw ranch, 6.46 miles northwest of, 1.99 miles northwest of Rigg ranch, 100 feet northwest of forks; iron post stamped "4840 1907"	4,851.918
Shaw ranch, 9.11 miles northwest of, west side of road; iron post stamped "4892 1907"	4,904.845
Shaw ranch, 12.84 miles northwest of, west side of road; iron post stamped "4940 1907"	4,952.383

[1] This is the last part of the line from Cochise in which an error of 3 feet has been thrown at the end and 0.5 foot adjusted; therefore one or more of the elevations may be 3 feet too low.

	Feet.
Apache Pass, 150 feet east of gap, north side of road, just south of ledge of rock; aluminum tablet stamped "5099 1907"	5,111.376
Apache Pass, 2 miles east of, at junction with old road north through canyon, west side of stream bed, 30 feet south of road, in rock; aluminum tablet stamped "4663 1907"	4,675.510

CHIRACAHUA QUADRANGLE.

Crossroads 3.7 miles east of Halfway station east to Shaw ranch, thence north 4.7 miles.[1]

West Well ranch, 16.23 miles east of, at forks at foot of hill on which is triangulation monument, south side of road east of forks; iron post stamped "5111 1907"	5,123.618
Shaw ranch, at forks about 0.5 mile west of, north side of road; iron post stamped "5281 1907"	5,293.275

Eagle City south to Paradise, thence southeast to Rodeo.

East Eagle City, 3.05 miles south of, 30 feet west of road, at sharp bend on top of hill leading to Turkey Creek, beside rock monument, in rock; aluminum tablet stamped "4969 1907"	4,979.510
Paradise, at forks of road just north of town, east side of creek, 15 feet south of telephone pole, 50 feet west of store of J. S. Cochran, on rock; aluminum tablet stamped "5386 1907"	5,396.673
Paradise, 2.81 miles southeast of, 8 feet south of road, 20 feet west of dry stream crossing, 8 feet north of live oak tree, in bowlder; aluminum tablet stamped "5128 1907"	5,138.809
Portals, 1,123 feet east of post office, 125 feet northeast of unoccupied dwelling 20 feet north of road, 20 feet east of telephone pole, in large rock; aluminum tablet stamped "4761 1907"	4,772.375
Portals, 3.37 miles southeast of, 10 feet east of road, in rock flush with ground; aluminum tablet stamped "4381 1907"	4,392.002
Portals, 7.21 miles southeast of, 100 feet west of road, in northeast corner of fence around windmill and water tank, in rock; aluminum tablet stamped "4101 1907"	4,111.812

COCHISE QUADRANGLE.

Cochise south along Arizona Eastern R. R. to Servoss.[2]

Cochise, 1.5 miles west of station, 100 feet south of milepost 1061; iron post stamped "147 1907"	4,277.550
Cochise, in front of station; top of rail	4,225.3
Cochise, 2.27 miles southeast of, 80 feet west of track, 350 feet south of old road crossing, 8 feet south of fence corner; iron post stamped "4179 1907"	4,189.964
Cochise, 4.57 miles southeast of, 85 feet west of railroad, 3 feet west of fence; iron post stamped "4178 1907"	4,189.265
Servoss, 100 feet east of track, 40 feet north of section house, 115 feet northeast of water tank; iron post stamped "4169 1907"	4,179.696

[1] Part of this line from Cochise closes 3 feet low near Apache Gap.

[2] This line continues on adjoining quadrangles and closes 3 feet low near Apache Pass on an adjusted elevation. An error of 0.5 foot has been adjusted, and an error of 3 feet thrown at the end of the line.

PEARCE QUADRANGLE.

Servoss southeast along Arizona Eastern R. R. to Pearce, thence west along road to crossroads 3.7 miles east of Halfway station.[1]

	Feet.
Cochise, 10.62 miles southeast of, 750 feet south of road crossing, 90 feet west of track, 10 feet east of wagon road, on west side of fence; iron post stamped "4235 1907"	4,246.297
Cochise, 13.7 miles southeast of, 100 feet west of track, west side of fence; iron post stamped "4308 1907"	4,318.610
Pearce, 0.37 mile east of station, 117 feet east of south switch, 160 feet east of Mr. Harper's yard; iron post stamped "4363 1907"	4,373.778
Pearce, in front of station; top of rail	4,392.5
Pearce, 3.27 miles east of, north side of road, 200 feet west of forks; iron post stamped "4305 1907"	4,315.763
Pearce, 5.83 miles east of, 8 feet south of wagon road; iron post stamped "4267 1907"	4,278.397
Pearce, 8.29 miles east of, 0.75 mile east of West Well ranch, north side of wagon road; iron post stamped "4297 1907"	4,308.363
Pearce, 11.47 miles east of, 3.93 miles east of West Well ranch, on north side of wagon road; iron post stamped "4358 1907"	4,368.878
Pearce, 14.34 miles east of, 6.8 miles east of West Well ranch, on north side of road; iron post stamped "4467 1907"	4,478.601
Pearce, 17.06 miles east of, 9.52 miles east of West Well ranch, 100 feet northeast of Halfway station, north side of wagon road; iron post stamped "4607 1907"	4,617.736
Halfway station, 3.13 miles east of, north side of road; iron post stamped "4799 1907"	4,810.206

At mouth of Dixie Canyon.

Dixie Canyon, at mouth of, on west side of water course at forks of trail; iron post stamped "4604 M. P. 92"	4,616.938

Boyles and Duncan 30′ Quadrangles.

GRAHAM COUNTY.

The elevations previously used for bench marks in the following list, taken partly from Bulletin 185, were based on an aluminum tablet marked "1090" in the north front of the Maricopa County courthouse at Phoenix, Ariz., and the permanent bench marks are, therefore, stamped "PHNX." These lines connect through New Mexico lines with a precise line at Silver City, and the elevations listed herein have been corrected by subtracting one foot from the previous values.

The leveling was done in 1900 by John T. Stewart and Thomas Winsor and in 1902–3 by Chester Irvine.

DUNCAN QUADRANGLE.

Point 7 miles east of Solomonsville northeast to point 6 miles southeast of Clifton.

	Feet.
Solomonsville, 8.5 miles northeast of, on south side of road, at junction with abandoned road at bend, 120 feet southwest of point where telephone line crosses road; iron post stamped "3400 PHNX"	3,398.937

[1] Part of the line closing 3 feet low at Apache Pass.

	Feet.
Solomonsville, 12 miles northeast of, in forks of road, 2.5 miles southwest of tollgate; iron post stamped "3706 PHNX"	3,704.752
Solomonsville, 14.5 miles northeast of, at southeast corner of gatekeeper's house on north side of road, 40 feet east of tollgate; iron post stamped "4090 PHNX"	4,089.198
Coronado, 11.5 miles southwest of, on southeast side of road, opposite brown cliffs, 3 miles east of tollgate; in top of large sloping pink rock; aluminum tablet stamped "4394 PHNX"	4,393.226
Coronado, 8.25 miles southwest of, 7 feet north of road at summit of pass over Peloncillo range; iron post stamped "4804 PHNX"	4,802.696
Coronado, 5.8 miles southwest of, 10 feet southeast of road opposite gulch from southeast, in top of malpais rock; aluminum tablet stamped "4386 PHNX"	4,385.297
Coronado, 2.5 miles southwest of, northwest side of road on rocky ridge, in top of ledge; aluminum tablet stamped "4037 PHNX"	4,036.029
Coronado, on east side of road near warning sign, 40 feet south of Arizona & New Mexico Railway track, 50 feet northeast of Coronado stage station; iron post stamped "3451 PHNX"	3,450.020
Arizona & New Mexico Railway crossing; top of rail	3,447.5
Gila River, bed of, at ford	3,429.0
Coronado, 3 miles northeast of, 15 feet south of point where road begins steep descent to Rattlesnake wash; iron post stamped "3816 PHNX"	3,814.665
Clifton, 6.5 miles southeast of, on north side of road at top of short steep hill, about 0.5 mile southwest of Phillips ranch; iron post stamped "4059 PHNX"	4,057.597

Clifton south along Arizona & New Mexico Ry. to Guthrie.

Clifton, 5.5 miles south of, 35 feet west of main track, 250 feet south of north head block at north siding, in top of embedded bowlder; aluminum tablet stamped "3798 PHNX"	3,796.731
Guthrie, 2.5 miles northwest of, 500 feet southeast of milepost 9, 20 feet southwest of and 8 feet above track; aluminum tablet stamped "3588 PHNX"	3,587.159
Guthrie, northeast corner of section yard, 130 feet south of station; iron post stamped "3415 PHNX"	3,413.892

Coronado south to Sheldon, thence west via Ash Peak Spring to Solomonsville.

Coronado, 4.5 miles southeast of, 13 feet southwest of track, on curve near mouth of York Canyon, in top of ledge; aluminum tablet stamped "3502"	3,501.251
Sheldon, 4.2 miles northwest of, 20 feet east of a trestle under which a wagon trail passes; iron post stamped "3520 PHNX"	3,519.043
Sheldon, 75 feet north of road crossing at station platform, 60 feet west of track; iron post stamped "3570 PHNX"	3,568.620
Sheldon, 3.3 miles southwest of, 25 feet south of road, near point where road leaves gulch and crosses small divide; iron post stamped "3926 PHNX"	3,924.936
Ash Peak Spring, 150 feet northeast of, 125 feet northeast of road; iron post stamped "4184 PHNX"	4,183.144
Ash Peak Spring, 2.3 miles west of, summit of divide, 25 feet north of road; marked "4398 PHNX"	4,396.946

	Feet.
Ash Peak Spring, 5.7 miles west of, 15 feet north of road; iron post stamped "4117 PHNX"	4,116.002
Ash Peak Spring, 8.9 miles west of, 20 feet north of road, 300 feet north of ravine; iron post stamped "3865 PHNX"	3,864.064
Ash Peak Spring, 11 miles west of, 20 feet north of road, west bank of ravine; iron post stamped "3706 PHNX"	3,705.014
Ash Peak Spring, 14 miles west of, 20 feet north of road; iron post stamped "3481 PHNX"	3,480.541
Ash Peak Spring, 17.1 miles west of, 20 feet north of road, west bank of ravine; iron post stamped "3295 PHNX"	3,294.151

Sheldon southeast along railroad to Duncan, thence along highway northeast 8.6 miles.

Sheldon, 75 feet north of road crossing at station platform, 60 feet west of track; iron post stamped "3570 PHNX"	3,568.620
Sheldon, 3.4 miles east of, 50 feet northwest of Arizona & New Mexico Railway bridge 95, 12 feet southwest of railroad fence corner; iron post stamped "3598 PHNX"	3,597.142
Sheldon, 4.2 miles east of, railroad bridge 100, top of south rail	3,606.39
Sheldon, 5.8 miles east of, 40 feet west of Ash Peak Spring road crossing, in fence post; railroad spike	3,620.25
Duncan, 100 feet northwest of Burtcher residence; iron post stamped "3643 PHNX"	3,642.234
Duncan, 0.8 mile north of, north gate post to ranch; wire nail near ground	3,660.01
Duncan, 3.3 miles south of, 30 feet east of road on side of small hill, stone monument, alongside bowlder; chiseled square on bowlder	3,846.10
Duncan, 5 miles north of, 20 feet west of road, on sunken bowlder; chiseled square	4,022.52
Duncan, 8.6 miles north of, 10 feet west of road, in stone; chiseled square	4,592.37

Bench marks southeast of Duncan.

Arizona-New Mexico boundary post, marked "No. 296 32° 11′ 30″ N. L.", 48 feet east of wagon road; iron post stamped "3736 PHNX"	3,735.361
Day ranch, 0.25 mile north of, 1.8 miles east of, end of ridge, 10 feet north of road, 40 feet north of large ditch; iron post stamped "3695 PHNX"	3,694.355

BOYLES QUADRANGLE.

Clifton southeast up Ward Canyon.

Clifton, southeast corner of post office and library building; iron post stamped "3465 PHNX"	3,464.165
Clifton, in front of station; top of rail	3,455.0
Clifton, 4.5 miles southeast of, in top of embedded red bowlder, 20 feet northeast of road at summit of hill, 600 feet east of telephone mile board 34; aluminum tablet stamped "4172 PHNX"	4,170.939

Clifton northwest along wagon road to Morenci, thence north via Longfellow mine and Chase Creek to Metcalf.

	Feet.
Clifton, 2.3 miles west of, north side of Chase Creek, 0.5 mile east of stone house, edge of road at foot of hill, in white rock 2 by 3 feet and 12 inches high; aluminum tablet stamped "3708 PHNX"	3,701.777
Clifton, 3.5 miles northwest of, top of east ridge on Clifton and Morenci wagon road, 75 feet north of fork of road, in white rock 2 by 3 feet and 12 inches high; aluminum tablet stamped "4316 PHNX"	4,315.079
Morenci, 0.9 mile southeast of, 500 feet below trestle of second loop going up canyon, west side of road at foot of cliff, 2 feet higher than road; aluminum tablet stamped "4541 PHNX"	4,539.811
Morenci, northeast corner of Detroit Copper Co.'s store, 0.5 foot higher than water table on main entrance; aluminum tablet stamped "4839 PHNX"	4,837.582
Morenci, north side of trail on top of divide between Detroit Copper Co.'s store and Longfellow mine, 125 feet northeast of company hospital; iron post stamped "4992 PHNX"	4,990.973
Longfellow mine incline, 300 feet northwest of foot of, 25 feet north of railroad, south bank of Chase Creek, large rock; aluminum tablet stamped "3989 PHNX"	3,988.162
Metcalf, 0.8 mile south of, east side of railroad track at foot of bluff, 300 feet northeast of stone house at foot of Queen mine incline, in rock ledge 10 feet higher than track; aluminum tablet stamped "4294 PHNX"	4,293.041
Metcalf, 900 feet south of Metcalf mine incline, east of railroad track, foot of rock ledge, 8 feet higher than track; aluminum tablet stamped "4415 PHNX"	4,413,928
Metcalf, southeast corner of Shannon Mine Co.'s office; iron post stamped "5543 PHNX"	5,542.103
Metcalf, summit of Shannon mountain; bronze tablet stamped "5628 PHNX"	5,626.935

Clifton up San Francisco River 6 miles.

Harper ranch, 1.9 miles north of, foot of east bluff of canyon, 300 feet east of river, 50 feet east of road; iron post stamped "3624 PHNX"	3,622.993
Harper ranch, 0.2 mile northeast of, east side of river at foot of cliff 25 feet high, 75 feet east of road; iron post stamped "3579 PHNX"	3,577.743
Evans Point, Moody's blacksmith shop, 500 feet east of southwest corner of, 25 feet north of river, north side of road, reddish granite ledge; aluminum tablet stamped "3542 PHNX"	3,540.765
Potter ranch, south side of entrance to, on west side of road; iron post stamped "3504 PHNX"	3,502.834
Clifton, 0.7 mile north of post office, east edge of road, east side of river, in foot of red ledge of rock; iron post stamped "3467 PHNX"	3,465.968

Big Lue ranch along highway southwest.

Big Lue ranch, 0.6 mile southwest of, at south gate to farm; surface of ground	6,082.84
Big Lue ranch, 2 miles southwest of, at forks of road, on bowlder; chisel mark	6,201.95

	Feet.
Big Lue ranch, 2.9 miles southwest of, north of and 4 feet above road, summit of mountain; aluminum tablet stamped "6382 PHNX"	6,380.951
Big Lue ranch, 4.1 miles southwest of, 10 feet east of trail, at drain crossing, on bowlder; chisel mark	5,686.17
Big Lue ranch, 5.5 miles south of, foot of mountains and forks of road; iron post stamped "5109 PHNX"	5,108.114
Big Lue ranch, 7.5 miles south of, east side of road, at foot of hill, on bowlder; chisel mark	4,589.56
Big Lue ranch, 10.4 miles south of, 20 feet north of road, near lone tree on flat; iron post stamped "4466 PHNX"	4,465.297
Big Lue ranch, 11.6 miles south of, 30 feet east of road, in drain, on bowlder; chisel mark	4,161.76

Point 8 miles north of Clifton, Ariz., up San Francisco River to Arizona-New Mexico line.

Harper ranch, 4.3 miles north of, 100 feet east of river, 30 feet east of road, on bowlder; chisel mark	3,667.73
Harper ranch, 5.5 miles north of, 20 feet west of road, at fence corner; iron post stamped "3699 PHNX"	3,698.076
Hays ranch, 150 feet east of house, 150 feet west of wagon road, 30 feet south of corral; iron post stamped "3778 PHNX"	3,777.066
Sutherlin ranch, 550 feet east of house, driven in top of stump, bolt	3,808.81
Sutherlin ranch, 1 mile northeast of, southwest fence corner of deserted ranch, north side of road and river, on bowlder; chiseled square	3,831.36
Blue Creek, mouth of, northwest corner of schoolhouse; iron post stamped "3866 PHNX"	3,864.876
Welch ranch, 0.3 mile south of, 40 feet east of road, 300 feet south of old house; iron post stamped "3973 PHNX"	3,971.564
Welch ranch, 1.5 miles north of, 10 feet east of road, in root of sycamore tree; wire nail	4,004.16
Welch ranch, 2.6 miles northeast of, 60 feet from road, 100 feet south of river and under high cliff; iron post stamped "4028 PHNX"	4,027.125
Welch ranch, 4.8 miles north of, 100 feet west of creek, 10 feet east of road, on bowlder; chiseled square	4,083.96
Welch ranch, 5.6 miles north of, 70 feet northeast of log cabin, 50 feet southeast of corral of deserted ranch; aluminum tablet stamped "4120 PHNX"	4,119.295
Welch ranch, 7.1 miles northeast of, 150 feet south of river, 30 feet north of road, on bowlder; chiseled square	4,151.04

Desert Well, Florence, Fort Thomas, Gila Butte, Gilson, Globe, Maricopa, Mesa, Phoenix, Ray, Sacaton, San Carlos, and Solomonsville Quadrangles.

GILA, GRAHAM, MARICOPA, AND PINAL COUNTIES.

The elevations in the following list are based on an aluminum tablet stamped "1090" set in north front of the Maricopa County courthouse at Phoenix, the elevation of which is now accepted as 1,089.910 feet above mean sea level.

The leveling was done in 1899 and 1900 by Thomas Winsor, in 1900 and 1901 by J. T. Stewart, and in 1902, 1903, and 1904 by the Reclamation Service.

The six following bench marks were established by the United States Reclamation Service in 1902, 1903, and 1904:

MARICOPA QUADRANGLE.

Along Arizona Eastern R. R. from milepost 899 to Sacaton.

	Feet.
Milepost 899, iron post stamped "1200 PHNX" (redetermined by precise leveling)	1,199.995
Maricopa, about 0.75 mile southeast of, northwest end of triangulation base line north side of track opposite milepost 897, bronze tablet (redetermined by precise leveling)	1,179.527
Maricopa, in front of station; top of rail	1,175.0
Maricopa, 75 feet west of station; iron post stamped "1175 PHNX" (redetermined by precise leveling)	1,174.891
Maricopa, 4.25 miles north of, west side of track; iron post stamped "1145 PHNX"	1,144.750
Sacaton station on the Arizona Eastern R. R., 60 feet south of switch head block; iron post stamped "1127 PHNX"	1,126.911

PHOENIX QUADRANGLE.

At Phoenix.

Phoenix, Maricopa County courthouse, north front of, in projection at northwest corner, 15 feet west of main entrance, 3 feet above ground; aluminum tablet stamped "1090 PHNX"	1,089.910
Phoenix, opposite Santa Fe, Prescott & Phoenix Ry. station; top of rail	1,081.5
Phoenix, on east side of Seventh Street, 100 feet southeast of Arizona Eastern R. R. station, between two cottonwood trees; iron post stamped "1083 PHNX"	1,082.920
Phoenix, opposite Arizona Eastern R. R. station; top of rail	1,082.0

At point 2 miles north of Phoenix.

Phoenix, 2 miles north of, northwest side of crossroads; iron post stamped "1096 PHNX"	1,095.988

Phoenix northeast along Camp Creek Road to Ashers ranch, thence down Rio Verde to Salt River.

Phoenix, 3.2 miles north of, 20 feet west of road, on ditch bank at forks of road 400 feet south of brick church; iron post stamped "1108 PHNX"	1,108.056

The following bench marks were established by the Reclamation Service in 1902, 1903, and 1904:

Northeast corner of sec. 31, T. 2 N., R. 4 E., northwest to permanent bench mark at southwest corner of sec. 18, T. 2 N., R. 3 E.

	Feet.
T. 2 N., R. 3 E., northwest corner of sec. 25; iron post stamped "1211 PHNX"	1,211.281
T. 2 N., R. 3 E., southwest corner of sec. 16; iron post stamped "1136 PHNX"	1,135.928
T. 2 N., R. 2 E., northeast corner of sec. 24; iron post	1,134.901

Southwest corner of sec. 19, T 2 N., R. 2 E., to "Six Points."

	Feet.
T. 2 N., R. 2 E., southwest corner of sec. 19, 100 feet north of crossroads, east side of road, in root of cottonwood tree; nail	1,092.42
T. 2 N., R. 2 E., southwest corner of sec. 30, southwest corner of crossroads, in root of large cottonwood tree; nail	1,077.77
T. 2 N., R. 2 E., southwest corner of sec. 31, northeast corner of crossroads, in root of large cottonwood tree; nail	1,059.33
T. 2 N., R. 1 E., southeast corner of sec. 36, 35 feet west of fence corner, near wire fence, north side of road; iron post stamped "1058 PHNX"	1,057.916
T. 2 N., R. 1 E., southeast corner of sec. 33, southeast corner of crossroads, in root of cottonwood tree; nail	1,075.53
T. 2 N., R. 1 E., southeast corner of sec. 34, north side of road, in front of schoolhouse, in root of cottonwood tree; nail	1,077.32
"Six Points," sec. 36, T. 2 N., R. 2 E., southeast corner of crossroads; iron post stamped "1081 PHNX"	1,080.450

Southwest corner of sec. 17, T. 2 N., R. 1 E., to southwest corner of sec. 24, T. 1 N., R. 1 E.

T. 2 N., R. 1 E., southwest corner of sec. 17, in root of cottonwood tree; nail	1,034.82
T. 2 N., R. 1 E., southwest corner of sec. 20, in root of large cottonwood tree; nail	1,022.66
T. 1 N., R. 1 E., in northwest corner of sec. 6, east side of road, 7 feet from fence (south) corner; iron post stamped "1000 PHNX"	999.878
T. 1 N., R. 1 E., southwest corner of sec. 30, northeast of junction of roads, in large mesquite tree; nail	943.55
T. 1 N., R. 1 E., northeast corner of sec. 1, northeast corner of crossroads, in root of cottonwood tree; nail	1,059.33
T. 1 N., R. 1 E., at southeast corner of sec. 12, at northeast corner of crossroads, in root of cottonwood tree; nail	1,029.62
T. 1 N., R. 1 E., 200 feet south of southeast corner of sec. 13, in stump of mesquite tree; nail	1,015.55
T. 1 N., R. 2 E., northwest corner of sec. 30, 35 feet south of ditch running west, 2 feet from small ditch running south, east side of road; iron post stamped "1006 PHNX"	1,005.751
T. 1 N., R. 1 E., on southwest corner stone of sec. 24	995.15

Sec. 30, T. 1 N., R. 1 E., to south bank of Gila River and return.

T. 1 N., R. 1 W., southeast corner of SE. ¼ sec. 36, 100 feet south of small grove of young cottonwood trees, on south bank of Gila River, 10 feet north of small ditch running west, initial point of survey of "Gila and Salt River base and meridian," northwest corner of small butte; iron post stamped "944 PHNX"	943.836

Southeast corner of sec. 24, T. 1 N., R. 1 E., southeast around western point of mountain range south of Phoenix to point on Arizona Eastern R. R. 1 mile south of Kyrene.

T. 1 N., R. 1 E., 100 feet west of southeast corner of sec. 24, in cottonwood tree; nail	1,005.273
T. 1 S., R. 1 E., 20 feet west of northeast corner stone of sec 1, south side of road along base line; iron post stamped "995 PHNX"	994.768

	Feet.
T. 1 S., R. 2 E., SE. ¼ sec. 20, edge of Indian reservation, 800 feet west of trading post, beside rock marked "G.R.I.R.B.M.," with monument of loose rock close by; iron post stamped "1052 PHNX"	1,051.678
T. 1 S., R. 2 E., SE. ¼ sec. 32, on town line, at northeast corner of St. John Chapel (large adobe building); iron post stamped "1031 PHNX"	1,030.504
T. 2 S., R. 3 E., SW. ¼ sec. 5, well 15 feet south of group of buildings at mine; iron post stamped "1127 PHNX"	1,126.768
T. 1 S., R. 3 E., in southeast corner of sec. 36, triangulation point; iron post stamped "1168 PHNX"	1,168.424

MESA QUADRANGLE.

Phoenix via Arizona Eastern R. R. to Tempe.

Phoenix, 4 miles east of, on west side of public road, 16 feet south of track; iron post stamped "1132 PHNX"	1,131.883
Bridge over Salt River; top of rail	1,165.0
Tempe, opposite station; top of rail	1,159.0
Tempe, north end of station, 50 feet east of main track; iron post stamped "1158 PHNX"	1,158.077

Tempe along Arizona Eastern R. R. to Mesa.

Tempe, 2.5 miles southeast of, on south side of road, opposite road running north; iron post stamped "1177 PHNX"	1,177.063
Mesa station, 1.5 miles northwest of, at northeast corner of crossroads, 30 feet north of track; iron post stamped "1235 PHNX"	1,235.109
Mesa, 250 feet southwest of station, near corner of wire fence on east side of public road; iron post stamped "1244 PHNX"	1,244.074

Mesa along Florence Road to Highland Canal.

Mesa, 3 miles southeast of, near wire fence corner at southeast corner of crossroads; iron post stamped "1243 PHNX"	1,243.146

Point 4 miles south of Kyrene north to Tempe.

Kyrene, 1 mile south of, 25 feet east of track on east side of public road; iron post stamped "1157 PHNX"	1,156.889
Kyrene, in front of signboard; top of rail	1,173.6
Kyrene, 1.5 miles north of, on top of bank 20 feet east of track, 180 feet south of culvert, west side of road; iron post stamped "1198 PHNX"	1,197.787
Tempe, 3.8 miles south of, 35 feet east of track, near fence, corner of field having small reservoir; iron post stamped "1188 PHNX"	1,187.686
Petersen, in front of signboard; top of rail	1,179.8

The following bench marks were established by the Reclamation Service in 1902, 1903, and 1904:

Mesa, Arizona Eastern R. R. station, northeast to T. 2 N., R. 6 E.

	Feet.
Mesa, opposite station; iron post stamped "1244 PHNX"	1,244.074
T. 2 N., R. 6 E., SE. ¼ sec. 29, in masonry abutment of waterway of Consolidated Canal; bronze tablet stamped "1273 PHNX"	1,273.336

Bridge over Arizona Canal at power house 3.7 miles southwest of Arizona Dam southwest along power line to northeast corner of sec. 31, T. 2 N., R. 4 E.

	Feet.
T. 2 N., R. 6 E., NE. ¼ sec. 20, at power line pole; iron post stamped "1281 PHNX"	1,280.422
T. 2 N., R. 5 E., 0.25 mile north of southwest corner of sec. 23 at power line pole; iron post stamped "1286 PHNX"	1,285.474
T. 2 N., R. 5 E., 0.12 mile west of north quarter corner of sec. 28; iron post stamped "1260 PHNX"	1,260.185
T. 2 N., R. 4 E., southeast corner of sec. 22; iron post stamped "1261 PHNX"	1,260.590
T. 2 N., R. 4 E., near southeast corner of sec. 31, about 100 feet northwest of highway bridge over cross-cut canal; iron post	1,192,203
T. 1 N., R. 3 E., near east quarter corner of sec. 12, 15 feet south of Arizona Eastern R. R. track; iron post stamped "1132 PHNX"	1,131.883

Point 1 mile south of Kyrene east 13 miles, thence southeast to permanent bench mark on road from Mesa to Desert Well.

T. 1 S., R. 4 E., southeast corner of sec. 33, in corner post; nail	1,162.39
T. 1 S., R. 4 E., southwest corner of sec. 34, 20 feet north of fence corner, east side of public road; iron post stamped "1166 PHNX"	1,166.239
T. 2 S., R. 5 E., 120 feet south of northwest corner of sec. 6, on line of wire fence; iron post stamped "1184 PHNX"	1,183.924
T. 1 S., R. 5 E., southeast corner of sec. 33, ditch along south side of fence at fence corner, on west side of public road; iron post stamped "1217 PHNX"	1,216.964
T. 1 S., R. 5 E., southeast corner of sec. 36; top of stone	1,238.91
T. 1 S., R. 5 E., sec. 36, on south side of abandoned irrigation ditch, wagon roads running north and south on both sides of post; iron post stamped "1252 PHNX"	1,251.586

DESERT WELL QUADRANGLE.

Highland Canal southeast along Florence Road to Desert Well.

Mesa, 6.25 miles southeast of, 60 feet south of road on north side of giant cactus about 30 feet high; iron post stamped "1295 PHNX"	1,295.179
Desert Well, 5.25 miles northwest of, 20 feet northeast of road at point where road forks into two wagon tracks; iron post stamped "1351 PHNX"	1,350.917
Desert Well, 2.25 miles northwest of, northeast side of road at bend, 25 feet southeast of small drain; iron post stamped "1407 PHNX"	1,407.092
Desert Well, at northeast corner of fence inclosing Thomas Buchanan's residence; iron post stamped "1446 PHNX"	1,446.035

Desert Well southeast 6 miles along public roads toward Florence.

Desert Well, 3 miles southeast of, on southwest side of road; iron post stamped "1490 PHNX"	1,489.970
Desert Well, 6 miles southeast of, on northeast side of road; iron post stamped "1592 PHNX"	1,542.047

Desert Well along Mesa and Silver King Road 6 miles.

Desert Well, 3 miles east of, 30 feet north of road; iron post stamped "1525 PHNX"	1,524.985
Desert Well, 6 miles east of, on north side of road, 150 feet west of small wash; iron post stamped "1609 PHNX"	1,609.033

Point northeast of Desert Well north to Goldfield.

	Feet.
Goldfield, 4 miles south of, on east side of road at bend; iron post stamped "1765 PHNX"	1,765.075
Goldfield, 1 mile southwest of, in forks, at junction with Mesa and Goldfield Road; iron post stamped "1934 PHNX"	1,934.015

The following bench marks were established by the Reclamation Service in 1902, 1903, and 1904:

At head gate of Consolidated Canal.

	Feet.
Head gate of Consolidated Canal, coping of northwest abutment	1,297.10

Point 0.3 mile northwest of Higley switch northeast to permanent bench mark on road between Mesa and Desert Wells.

Higley switch, 0.3 mile northwest of; T. 1 S., R. 6 E., center of sec. 28, beside telegraph pole, on southwest side of Arizona Eastern R. R.; iron post stamped "1290 PHNX"	1,290.107
Mesa, northeast of, on road to Desert Well; iron post stamped "1350 PHNX"	1,350.917

FLORENCE QUADRANGLE.

Point 6 miles southeast of Desert Well southeast to Florence.

Desert Well, 9 miles southeast of, on northeast side of road in open place on desert; iron post stamped "1601 PHNX"	1,601.028
Desert Well, 12 miles southeast of, on northeast side of road about 0.5 mile southeast of Queen Creek; iron post stamped "1631 PHNX"	1,630.995
Florence, 11.8 miles northwest of, on northeast side of road beside mesquite stump near bend; iron post stamped "1631 PHNX"	1,631.157
Florence, 8.5 miles northwest of, 35 feet northwest of crossroad; iron post stamped "1618 PHNX"	1,618.058
Florence, 6 miles north of, on west side of road; iron post stamped "1595 PHNX"	1,595.018
Florence, 4 miles north of, in forks of road at junction with road running northeast to Raymert, 7 feet north of guideboard "Gold fields, 26 miles; Florence, 4 miles;" iron post stamped "1619 PHNX"	1,618.957
Florence, 1.25 miles north of, in forks of road at junction with road running northwest; iron post stamped "1479 PHNX"	1,478.952
Gila River, bed of, center of stream at road crossing	1,459.
Florence, west front of Pinal County courthouse in southwest corner of west wing, about 3 feet above ground; aluminum tablet stamped "1493 PHNX"	1,492.835

Florence west 6.8 miles.

Florence, 3.8 miles southwest of, 50 feet west of forks of road, about 1,000 feet east of Adamsville ruins; iron post stamped "1441 PHNX"	1,440.848
Florence, 6.8 miles southwest of, on north side of road, 100 feet southeast of adobe ruins; iron post stamped "1421 PHNX"	1,420.853

Florence along Canal Road to The Buttes.

	Feet.
Florence, 2.5 miles east of, in forks of Butte-Florence and Florence-Kelvin Roads, 50 feet west of canal; iron post stamped "1534 PHNX"	1,534.088
Florence, 3 miles northeast of, near wire fence corner, at junction with dim road west on north line of sec. 32, T. 3 S., R. 10 E., 700 feet southwest of adobe ranch house; iron post stamped "1535 PHNX"	1,534.853
Florence, 6 miles northeast of, by a wire fence corner on northwest side of road, opposite forks; iron post stamped "1531 PHNX"	1,530.992
White ranch, 0.8 mile east of, top of granite ledge on southwest bank of Gila River, 150 feet southeast of canal head gate; aluminum tablet stamped "1574 PHNX"	1,573.539
The Buttes, gaging station; zero point of gage rod	1,581.94
The Buttes, face of cliff, west side of Gila River, 4.25 feet above surface on axis of proposed dam; bronze tablet stamped "1592 PHNX"	1,592.308

The Buttes along road via Donnelly's Well to Florence.

Donnelly's Well, 0.5 mile southwest of, on south side of road, at bend on top of hill; iron post stamped "2281 PHNX"	2,281.000
Donnelly's Well, 4 miles west of, on east side of road near north bank of small wash; iron post stamped "2097 PHNX"	2,097.065
Donnelly's Well, 7 miles west of, on south side of road at top of small hill; iron post stamped "1929 PHNX"	1,929.118
Florence, 6.5 miles east of, 75 feet southeast of junction with road running to Mammoth; iron post stamped "1769 PHNX"	1,769.178

Point 6 miles east of Desert Well east along Silver King Road to Hewitt ranch.

Desert Well, 9 miles east of, on north side of road at bend, 35 feet southeast of small wash; iron post stamped "1710 PHNX"	1,710.130
Whitlow ranch, 8.5 miles west of, on north side of road; iron post stamped "1832 PHNX"	1,831.763
Whitlow ranch, 5.25 miles west of, on south side of road, standing 2 feet above surface of ground, surrounded by mound of bowlders and earth; iron post stamped "1923 PHNX"	1,922.890
Whitlow ranch, 2.8 miles west of, in top of sandstone ledge on north, west side of road, at base of rocky hill, 40 feet northwest of Queen Creek; aluminum tablet stamped "1962 PHNX"	1,962.120
Queen Creek gaging station; zero of gage rod	2,042.14
Whitlow ranch, 1,000 feet east of, on sloping ledge 13 feet south of south edge of Queen Creek bed, on axis of proposed dam; bronze tablet stamped "2056 PHNX"	2,056.299

Hewitt ranch along Mesa and Silver King Road to Pinal.

Hewitt ranch, 1 mile east of, east side of road, 70 feet northwest of Queen Creek; iron post stamped "2171 PHNX"	2,170.682
Pinal, 3 miles west of, side hill, south side of road, 100 feet east of a wash; iron post stamped "2336 PHNX"	2,335.956
Pinal, top of sandstone outcrop 500 feet north of town, east side of road; aluminum tablet stamped "2529 PHNX"	2,528.821

Pinal north to Silver King, thence southwest to point west of Pinal.

	Feet.
Silver King, 2 miles southwest of, top of pink sandstone bowlder on east side of road, 170 feet north of wash; aluminum tablet stamped "3023 PHNX"	3,022.725
Silver King, south side of road at summit of steep hill on west edge of town; iron post stamped "3553 PHNX"	3,552.539
Silver King, 4.8 miles southwest of, northwest side of road, at junction with road running north to Whitford ranch; iron post stamped "2561 PHNX"	2,560.681

Point near Pinal southwest via Reymert to bench mark 4 miles north of Florence.

Reymert, 4 miles northeast of, north side of road near end of brush fence, 75 feet north of house at Nicholas ranch; iron post stamped "2406 PHNX"	2,405.546
Reymert, 0.8 mile northeast of, northeast side of road, at south end of deep cut on summit of hill; iron post stamped "3160 PHNX"	3,160.207
Reymert, 2.25 miles southwest of, southeast side of road at bend; iron post stamped "2321 PHNX"	2,321.24
Reymert, 5.8 miles southwest of, northwest side of road at bend, 35 feet north of small wash; iron post stamped "2004 PHNX"	2,003.514
Reymert, 8.25 miles southwest of, east side of road, 25 feet southeast of small wash; iron post stamped "1845 PHNX"	1,844.594
Florence, 9 miles northeast of, northwest side of road opposite forks, at junction with road running northeast to Whitlow ranch; iron post stamped "1725 PHNX"	1,724.487
Florence, 6.5 miles northeast of, on east side of road at junction with old wood road; iron post stamped "1646 PHNX"	1,645.527

Whitlow ranch southwest to point 9 miles northeast of Florence.

Whitlow ranch, 2 miles southwest of, 50 feet northeast of forks at junction with old Florence and Silver King Road; iron post stamped "2062 PHNX"	2,061.858
Whitlow ranch, 5.25 miles southwest of, southeast side of road; iron post stamped "1926 PHNX"	1,925.841
Whitlow ranch, 8 miles southwest of, northwest side of road; iron post stamped "1841 PHNX"	1,840.577

Point 3.5 miles west of Whitlow ranch north to Bark ranch, thence southwest to main road.

Bark ranch, 2.8 miles south of, in forks of road at junction with road running north to Bark ranch; iron post stamped "2056 PHNX"	2,055.792
Bark ranch, north side of road, 80 feet west of house; iron post stamped "2236 PHNX"	2,235.574
Bark ranch, 6.25 miles southwest of, south side of road at bend, 30 feet east of small wash; iron post stamped "1863 PHNX"	1,862.840

Point east of Desert Well north along Florence and Goldfield road.

Goldfield, 7 miles south of, west side of road, at junction with old wood road running southwest; iron post stamped "1694 PHNX"	1,694.096

Donnelly's well along Florence and Riverside road to point near Riverside.

	Feet.
Donnelly's well, 3.25 miles east of, northeast side of road at bend where road crosses a wash; iron post stamped "2625 PHNX"	2,624.894
Donnelly's well, 6.25 miles east of, at summit of hill, highest point between Florence and Riverside; iron post stamped "3081 PHNX"	3,081.115
Riverside, 5 miles southwest of, southeast side of road at bend on ridge; iron post stamped "2250 PHNX"	2,249.726

Ray northwest along Salt River valley and Mineral Creek wagon road to Pinal.

Ray, 3.25 miles northwest of, east side of gulch, at bend, in top of projecting ledge; aluminum tablet stamped "2838 PHNX"	2,837.758
Ray, 6.25 miles northwest of, in top of limestone ledge on south side of road, at summit of hill; aluminum tablet stamped "3761 PHNX"	3,760.401
Pinal, 5.8 miles southeast of, northeast side of canyon, opposite spring, 4.5 feet above bed of canyon, in sandstone ledge; aluminum tablet stamped "2953 PHNX"	2,952.316
Pinal, 2.8 miles southeast of, on northeast side of road, on top of a rocky mound, 250 feet northwest of wash, in top of embedded bowlder; aluminum tablet stamped "2682 PHNX"	2,681.867

Point near Goldfield northeast along Roosevelt road to Mormon Flat.

Goldfield, 1 mile southwest of, in forks at junction of Mesa and Goldfield roads; iron post stamped "1934 PHNX"	1,934.015
Goldfield, 1.7 miles northeast of, 30 feet east of road, on ridge 1,300 feet east of Black Queen mine; iron post stamped "2105 PHNX"	2,105.106
Goldfield, 3.5 miles northeast of, at Government Well stage station, 300 feet northeast of well, 20 feet east of road; iron post stamped "2107 PHNX"	2,107.336

SACATON QUADRANGLE.

Point 6.8 miles west of Florence west to Sacaton.

Blackwater Chapel, 3.25 miles southeast of, on north side of road opposite a division fence near bend in road, 150 feet southeast of adobe ruins; iron post stamped "1397 PHNX"	1,396.925
Blackwater Chapel, 500 feet northwest of, 75 feet northwest of forks of roads; iron post stamped "1362 PHNX"	1,361.830
Blackwater Chapel, 3 miles northwest of, 50 feet southeast of junction with road running southeast; iron post stamped "1354 PHNX"	1,353.886
Sacaton, 3.8 miles east of, on northwest side of road near bend, 180 feet west of new ditch running north and south; iron post stamped "1305 PHNX"	1,305.007
Sacation, on north side of gate, east side of Pima Indian agency grounds; iron post stamped "1274 PHNX"	1,274.117

GILA BUTTE QUADRANGLE.

Sacaton northwest to Sacaton Station.

Sacaton, 3 miles west of, south side of road, east bank of small drain; iron post stamped "1251 PHNX"	1,250.843
Sacaton, 6 miles west of, north side of road, west edge of open flat; iron post stamped "1223 PHNX"	1,222.933

	Feet.
Casa Blanca, 3 miles northeast of, south side of road near Indian village, about 0.25 mile southeast of a Catholic chapel; iron post stamped "1198 PHNX"	1,197.894
Casa Blanca, near corner on north side of wire fence, near fork of roads; 350 feet north of mission chapel; iron post stamped "1181 PHNX"	1,180.848
Casa Blanca, 3 miles west of, on north side opposite forks at junction with a road running north; iron post stamped "1163 PHNX"	1,162.826
Sacaton, south side of public road, 25 feet west of Arizona Eastern R. R. track, 60 feet south of switch head block; iron post stamped "1127 PHNX"	1,127.111

Sacaton north along Arizona Eastern R. R. to point 4 miles south of Kyrene.

Sacaton, bridge over Gila River; top of rail	1,126.5
Sacaton, under bridge, bed of Gila River	1,119
Sacaton, 3 miles north of, 30 feet west of track, near telegraph pole, 300 feet north of vitrified tile culvert; iron post stamped "1133 PHNX"	1,132.975
Kyrene, 4 miles south of, 25 feet west of track, beside telegraph pole; iron post stamped "1140 PHNX"	1,139.788

The following bench marks were established by the Reclamation Service in 1902, 1903, and 1904:

Southeast corner of T. 1 S., R. 5 E., south to permanent bench mark on road 6 miles west of Sacaton Indian Agency.

	Feet.
T. 2 S., R. 5 E., at east quarter corner of sec. 24, at stake; iron post stamped "1258 PHNX"	1,258.231
T. 2 S., R. 5 E., southeast corner of sec. 36; iron post stamped "1255 PHNX"	1,255.034
T. 3 S., R. 6 E., southwest corner of sec. 19, 1,000 feet north of old Indian cemetery, 1,000 feet southeast of forks of road, by adobe house, iron post stamped "1246 PHNX"	1,245.570
Sacaton Indian agency, 6 miles west of; iron post stamped "1223 PHNX"	1,222.733

Point 6 miles west of Sacaton Indian Agency south to Sweetwater, on Southern Pacific R. R., west to Maricopa, thence north to Sacaton, on Arizona Eastern R. R.

T. 4 S., R. 5 E., northwest corner of NE. ¼ sec. 30, 800 feet east of the most easterly butte of a group of buttes, on the highest point of which group is a triangulation point known as Sacaton Butte; iron post stamped "1289 PHNX"	1,288.880
T. 4 S., R. 4 E., sec. 35, 1 mile northwest of triangulation point Mica Butte in SE. ¼ sec. 35, 4 miles north of Sweetwater; iron post stamped "1303 PHNX"	1,303.276
Sweetwater, at well; iron post stamped "1297 PHNX" (redetermined by precise leveling)	1,297.022
Sweetwater, in front of station; main track, top of rail	1,298.3
Maricopa, 5.5 miles southeast of, southeast end of triangulation base line, north side of track opposite milepost 902, bronze tablet (redetermined by precise leveling)	1,225.706
Lirim switch, top of rail	1,232.4

RAY QUADRANGLE.

Point near Riverside northeast to Riverside.

	Feet.
Riverside, 2 miles southwest of, on southeast side of road, 200 feet northeast of junction with road running northeast to Piety Flat; iron post stamped "1940 PHNX"	1,939.630
Riverside, in top of embedded bowlder at southwest corner of small corral 120 feet northeast of post office; aluminum tablet stamped "1778 PHNX"	1,777.292

Riverside northeast along Globe and Riverside road to Pioneer.

Riverside, Gila River, bed of, at road crossing	1,758.5
Riverside, 3 miles northeast of, on southwest side of road, 400 feet west of point where road crosses wash, in top of granite bowlder; bronze tablet stamped "2511 PHNX"	2,510.056
Troy, east side of road at summit of hill, opposite road running southwest to mine, in top of granite bowlder; aluminum tablet stamped "3644 PHNX"	3,643.233
Dripping Spring, 1 mile west of, southwest side of road, at gate on northwest side of a filled rail fence; iron post stamped "2986 PHNX"	2,985.428
Dripping Spring, 2 miles northeast of, in top of hard sandstone bowlder 15 feet east of road, 30 feet south of small wash; bronze tablet stamped "2995 PHNX"	2,994.757
Pioneer, 3.25 miles south of, northeast side of road at bend, at point where road leaves ridge and ascends steep side hill; iron post stamped "3846 PHNX"	3,845.328
Pioneer, east side of road, 40 feet southwest of stage station, in top of granite bowlder; aluminum tablet stamped "4505 PHNX"	4,504.436

Dudleyville along Mammoth and Riverside road to Riverside (portion of line).

Dudleyville, 6 miles northwest of, north side of road, at bend; iron post stamped "1866 PHNX"	1,865.078
Riverside, 6.5 miles southeast of, southwest side of road, at summit of hill; iron post stamped "1927 PHNX"	1,926.045
Riverside, 3.3 miles southeast of, on west side of road, at bend, on summit of hill; iron post stamped "1828 PHNX"	1,826.931

Riverside along Mineral Creek road to Ray.

Kelvin, 2.25 miles north of, on west side of road, northwest bank of Mineral Creek, about 800 feet south of large eroded cliff; iron post stamped "1869 PHNX"	1,868.442
Ray, in top of low ledge on east side of road nearly opposite mill, 100 feet north of company store; aluminum tablet stamped "2024 PHNX"	2,023.894

GLOBE QUADRANGLE.

Pioneer north to Globe.

Pioneer, 3.8 miles north of, southeast side of road, at summit of pass over Pinal Mountains; iron post stamped "6158 PHNX"	6,157.312
Globe, 7.5 miles south of, east side of road at bend, in top of large granite bowlder; bronze tablet stamped "4962 PHNX"	4,961.822

	Feet.
Globe, 4 miles southeast of, south side of gate, west side of road, at ranch "66"; iron post stamped "3825 PHNX"	3,824.468
Globe, 2.5 miles southeast of, on southwest side of road, at northeast corner of small corral opposite slaughterhouse; iron post stamped "3637 PHNX"	3,636.324
Globe, Gila County courthouse, in west face of, at southwest corner 2 feet above ground; aluminum tablet stamped "3525 PHNX"	3,524.298

Globe southeast along Arizona Eastern R. R. 2.5 miles.

Globe, opposite station; top of rail	3,508.5
Globe, 2.5 miles southeast of, on top of hill 0.5 mile south of railway, meridian mark; tablet stamped "3885 PHNX"	3,884.669
Globe, 2.5 miles southeast of, by warning post on south side of track at public road crossing, 600 feet west of summit of hill; iron post stamped "3720 PHNX"	3,719.226

Globe west along Globe and Payson road to Black Warrior.

Globe, 0.8 mile northwest of courthouse, 12 feet west of railroad track, at wagon road crossing; iron post stamped "3461 PHNX"	3,460.393
Globe, 2.5 miles northwest of, on northeast side of road, opposite forks, at junction with Black Warrior road; iron post stamped "3348 PHNX"	3,347.446
Black Warrior, 1.25 miles southeast of, in top of brown sandstone rock 5 feet diameter by 3 feet high, 150 feet northwest of saloon, on southwest side of road, at mouth of Webster Gulch; aluminum tablet stamped "3349 PHNX"	3,348.523

Black Warrior west to Continental mine.

Black Warrior, 1.8 miles west of, 6 feet east of triple live oak tree, at bend on south side of road, in top of sandstone bowlder; aluminum tablet stamped "3759 PHNX"	3,758.692
Black Warrior, 5.5 miles west of, 25 feet northeast of road, 100 feet north of summit of hill on divide between Webster and Pinto Creeks, about 1 mile east of Continental copper mine; in top of sandstone bowlder; aluminum tablet stamped "4578 PHNX"	4,577.412

Miami Flat southwest via Shultz ranch to point 6 miles south of Shultz ranch, thence east and northeast to Globe.

Shultz ranch, 2.8 miles northeast of, on southwest side of western pass toll road, on southwest bank of Bloody Tanks wash, opposite Burnett goat ranch; iron post stamped "3468 PHNX"	3,467.414
Shultz ranch, 0.25 mile southwest of, 45 feet southwest of gate; iron post stamped "3906 PHNX"	3,905.300
Shultz ranch, 3.8 miles southwest of, on east side of road, at base of short, steep hill, in top of schist ledge; aluminum tablet stamped "4523 PHNX"	4,522.226
Shultz ranch, 6.5 miles southwest of, on north side of road, on bank of Pinto Creek, in top of schist ledge; aluminum tablet stamped "4864 PHNX"	4,863.204
Globe, 11 miles southwest of, on north side of trail, 150 feet east of summit of mountain, 20 feet northeast of 15-inch pine tree, in top of granite bowlder; aluminum tablet stamped "6487 PHNX"	6,485.822

	Feet.
Globe, 8.25 miles southwest of, on south side of small ravine, on east side of ridge toll road, 150 feet northeast of bridge across gulch, in top of gneiss rock; bronze tablet stamped "4857 PHNX"	4,856.483
Globe, 5.25 miles southwest of, 15 feet northeast of road, 50 feet north of sharp bend, in top of granite bowlder; aluminum tablet stamped "4438 PHNX"	4,437.142

Globe northwest along Globe and Payson road to Harrold ranch.

Globe, 6 miles northwest of, in front of circular corral on northeast side of road, at Harrold ranch, 9 feet southeast of 36-inch cottonwood tree; iron post stamped "3170 PHNX"	3,169.440

Globe north along road via Big Johnnie Gulch, thence east over divide just south of Big Johnnie mine to Copper Gulch, thence northeast 0.3 mile and return southwest along Copper Gulch to Globe.

Between Big Johnnie Gulch and drainage flowing to Buffalo smelter; 100 feet southwest of road; in limestone bowlder in hillside; bronze tablet stamped "3942"	3,941.617
Big Johnnie Gulch and Copper Gulch, between; top of divide, in rock outcrop, 40 feet west of road, through saddle in divide; bronze tablet stamped "4206"	4,205.090
Head of Copper Gulch, 15 feet south of wagon road, on divide; bronze tablet stamped "4136"	4,135.313
Between Hoosier and the Gray mines, 180 feet north of water tanks, on top of ridge, 40 feet north of wagon road, in concrete bowlder; bronze tablet stamped "3979"	3,978.682

Herrell ranch north on Livingston road to Hicks ranch.

Geralds ranch, 300 feet north of house, 200 feet west of Pinal Creek, 20 feet east of road, at fence corner, in stone flush with ground; aluminum tablet stamped "3069 PHNX"	3,068.478
Hicks ranch, 20 feet west of Globe Road, in front of circular corral; iron post stamped "2990 PHNX"	2,990.032

GILSON QUADRANGLE.

Point near Globe east along Arizona Eastern R. R. to Rice.

Globe, 5.8 miles southeast of, 15 feet southwest of track at southeast end of cut, 75 feet southeast of point of curvature; iron post stamped "3402 PHNX"	3,401.277
Cutter, east head block at; top of rail	3,256.5
Gilson's, 3.5 miles west of, by telegraph pole on north side of track; iron post stamped "3168 PHNX"	3,167.088
Gilson's, 0.25 miles west of water tank, by first telegraph pole west of public-road crossing, on north side of track; iron post stamped "3013 PHNX"	3,012.269
Gilson's, 2.8 miles southeast of, 10 feet south of track, east side of public-road crossing, 300 feet east of trestle 229; iron post stamped "2891 PHNX"	2,890.292
Rice, 2.8 miles northwest of, in front of second telegraph pole east of trestle 227; iron post stamped "2748 PHNX"	2,747.170
Rice, at northwest corner of crossroads, 180 feet east of switch-head block; iron post stamped "2635 PHNX"	2,634.255

SAN CARLOS QUADRANGLE.

Rice south along Arizona Eastern R. R. to San Carlos.

	Feet.
Rice, 3 miles south of, 40 feet west of track, north side of wagon road; iron post stamped "2585 PHNX"	2,584.359
San Carlos, 4.5 miles north of, 25 feet east of track, east side of wagon road; iron post stamped "2540 PHNX"	2,539.269
San Carlos, 1.8 miles north of, 25 feet southwest of track, at public road crossing; iron post stamped "2470 PHNX"	2,469.295
San Carlos, opposite station; top of rail	2,431.200
San Carlos, 150 feet northwest of station, 45 feet southwest of main track; iron post stamped "2431 PHNX"	2,430.216

San Carlos via Hawk Canyon to Wooten ranch.

San Carlos, south of, Gila River, bed of	2,385.500
San Carlos, 3 miles south of, on east side of road, north side of small wash; iron post stamped "2671 PHNX"	2,670.115
San Carlos, 6 miles south of, on southwest side of road on top of hill, 45 feet west of U. S. Army telegraph pole; iron post stamped "3573 PHNX"	3,572.289
Wooten ranch, 6.25 miles north of, in limestone outcrop, 15 feet west of road, 25 feet northwest of small wash; bronze tablet stamped "3810 PHNX"	3,809.534
Wooten ranch, 3.25 miles north of, in top of rock 9 by 6 feet, 3 feet above surface, 35 feet southwest of wash, near base of tall cliff; aluminum tablet stamped "3454 PHNX"	3,453.041
Wooten ranch, in top of large rock, 200 feet southwest of cabin, 40 feet northwest of trail, 30 feet west of 38-inch leaning sycamore tree; bronze tablet stamped "3911 PHNX"	3,910.268

San Carlos southeast along Arizona Eastern R. R. to Fort Thomas.

San Carlos, 4.5 miles southeast of, 12 feet southwest of track, 230 feet southeast of trestle 206, opposite Indian trail crossing; iron post stamped "2458 PHNX"	2,457.205
San Carlos, 6.8 miles southeast of, in front of first telegraph pole northwest of county road crossing near Indian farm; iron post stamped "2504 PHNX"	2,503.023
San Carlos, 9.8 miles southeast of, 50 feet south of track opposite county road crossing, 1 mile west of Dewey siding; iron post stamped "2508 PHNX"	2,507.024
Geronimo, 11.25 miles northwest of, 25 feet northeast of track at east end of track opposite adobe ruins of old subagency buildings; iron post stamped "2550 PHNX"	2,548.998
Geronimo, 9 miles northwest of, by first telegraph pole northwest of mile board 77, 100 feet south of trestle 189; iron post stamped "2586 PHNX"	2,585.042
Geronimo, 6.5 miles northwest of, 150 feet west of county road crossing at Navajo Point, 10 feet north of road; iron post stamped "2586 PHNX"	2,584.837
Geronimo, 4.5 miles northwest of, by wire fence, 50 feet northwest of track and opposite county road crossing, 0.8 mile southeast of Indian farm; iron post stamped "2606 PHNX"	2,604.859

	Feet.
Geronimo, at southeast corner of Alexander Bros.' general store, 300 feet north of track; iron post stamped "2633 PHNX"	2,631.931
Fort Thomas, 2.25 miles northwest of, 30 feet southwest of track, on east side of wagon road coming in to railroad from the south, 350 yards southeast of mile board 64; iron post stamped "2673 PHNX"	2,671.937

FORT THOMAS QUADRANGLE.

At and near Fort Thomas.

Fort Thomas, 500 yards southeast of station, 30 feet south of wagon road crossing, 150 yards west of Alexander Bros.' general store; iron post stamped "2701 PHNX"	2,699.968
Fort Thomas, 3 miles southeast of, 9 feet east of wire fence corner, 30 feet northeast of county road crossing, 0.5 mile southeast of mile board 59; iron post stamped "2724 PHNX"	2,722.739

SOLOMONSVILLE QUADRANGLE.

Point near Fort Thomas southeast along Arizona Eastern R. R. to Solomonsville.

Matthew post office, 0.3 mile northwest of, near telegraph pole at mile board 55, 80 feet southeast of section house; iron post stamped "2755 PHNX"	2,753.683
Matthews post office, 1 mile northwest of, near angle of wire fence, 50 feet north of track at forks in road, 250 feet northwest of mile board 53; iron post stamped "2783 PHNX"	2,781.538
Matthews post office, 1.5 miles southeast of, near telegraph pole, 30 feet northeast of track, 100 feet southwest of Barney's store; iron post stamped "2813 PHNX"	2,811.820
Pima, 200 feet west of station, near warning signpost, 30 feet south of main track; iron post stamped "2843 PHNX"	2,841.764
Central, 50 feet southeast of road crossing, 300 feet west of church, and opposite mile board 45; iron post stamped "2883 PHNX"	2,881.596
Thatcher, northwest end of station grounds, east side of wagon road, 30 feet south of track, 35 feet southwest of switch head block; iron post stamped "2931 PHNX"	2,929.345
Safford, 140 feet east of station, east side of street, 15 feet north of main track, 3 feet west of telephone pole; iron post stamped "2923 PHNX"	2,921.656
Safford, 2.5 miles southeast of, in front of telephone pole on south side of county road between Safford and Solomonsville, 15 feet southwest of track; iron post stamped "2952 PHNX"	2,950.557
Solomonsville, near telegraph pole, 100 feet east of station, 20 feet southwest of main track; iron post stamped "2979 PHNX"	2,977.733
Solomonsville, in middle of front of school building, 3.5 feet above ground; aluminum tablet stamped "2976 PHNX"	2,974.754

Solomonsville east 7 miles.

Solomonsville, 3,25 miles east of, in forks of road at junction of Solomonsville and Coronado toll road with Solomonsville and Duncan County Road, 40 feet east of toll-road signboard; iron post stamped "3098 PHNX"	3,096.655

	Feet.
Solomonsville, 5.5 miles northeast of, on northwest side of road at bend; iron post stamped "3208 PHNX"	3,206.745
Solomonsville, between 6.5 miles and 7.5 miles northeast of, junction with first road running north; ground	3,287.0
Solomonsville, between 6.5 and 7.5 miles northeast of, junction with second road running north; ground	3,312.0

Solomonsville southeast toward Ash Peak Springs.

Solomonsville, 3.5 miles east of, fork of Coronado toll road and Duncan road; iron post stamped "3098 PHNX"	3,096.655
Ash Peak Spring, 19.4 miles west of, 15 feet north of road, south bank of ravine; iron post stamped "3195 PHNX"	3,194.130

Bradshaw Mountains, Camp Verde, Congress, Jerome, New River, Santa Maria Mountains, and Wickenburg Quadrangles.

MARICOPA AND YAVAPAI COUNTIES.

The elevations in the following list are based on mean sea level datum in agreement with the unadjusted elevations of bench marks at Ashfork established by the Coast and Geodetic Survey in 1909. Part of the elevations were originally based on an iron post in the grounds of and 20 feet north of the courthouse at Prescott. The elevation of that bench mark is now accepted as 5,353.314 feet above mean sea level.

The leveling in the Bradshaw Mountains quadrangle was done by J. P. Darling and J. T. Stewart in 1900 and 1901; the work in the New River, Jerome, Santa Maria Mountains, and Congress quadrangles was done in 1901, 1902, and 1903 by J. T. Stewart.

All bench marks depending on the Prescott datum are stamped with the letters "PRSCT," in addition to the figures of elevation.

The remaining elevations in the New River and Wickenburg quadrangles, where bench marks are stamped "PHNX," were originally based on the aluminum tablet in the courthouse at Phoenix, stamped "1090," the accepted elevation of which is 1,089.910 feet above mean sea level. The leveling was done in 1903 by J. T. Stewart.

BRADSHAW MOUNTAINS QUADRANGLE.

Point 2.25 miles south of Prescott south via Bueno, Senator mine, Minnehaha, and Lehman's mine, to Briggs.

	Feet.
Whiteside's house, 0.4 mile south of, 0.6 mile north of Groom Creek bridge; iron post stamped "6149 PRSCT"	6,156.834
Kelly's station, 0.25 mile south of, 0.8 mile north of forks of road to Reliance mine, top of small hill 10 feet north of road; iron post stamped "6396 PRSCT"	6,403.647
Covered bridge, 1.6 miles south of, at intersection of Mount Union and Crown King Roads and on divide between Maple Gulch and Crook Canyon; iron post stamped "7187 PRSCT"	7,194.955
Palace station, 75 feet north of, 1.4 miles south of burnt mill, 20 feet west of road; iron post stamped "5847 PRSCT"	5,854.897

	Feet.
Coys, 125 feet west of station, at intersection of Crown King and Pine Flat Roads, 10 feet south of road, in outcrop of rock; aluminum tablet stamped "5563 PRSCT"	5,570.108
Bueno, or Johnson's station, 125 feet north of house, 3 feet east of road, in rock; aluminum tablet stamped "5258 PRSCT"	5,265.787
Bueno, 2.25 miles south of, on divide between Battle Flat and Blind Indian Creeks, 8 feet east of road; iron post stamped "5740 PRSCT"	5,747.774
Roach's quartz mill, 0.3 mile north of, top of hill between Blind Indian Creek and a small creek, 15 feet east of road; iron post stamped "5390 PRSCT"	5,397.603
Hooper post office, 1.5 miles south of, in forks of Crown King and Minnehaha Roads; iron post stamped "5968 PRSCT"	5,975.301
Minnehaha, 3.5 miles north of, at Peterson ranch (deserted), east side of road; iron post stamped "5244 PRSCT"	5,251.371
Minnehaha, 75 feet south of post office, east side of road, 1,400 feet south of Buttons mine; iron post stamped "5440 PRSCT"	5,447.347
Minnehaha, 3.3 miles southwest of, 200 feet southwest of old Fenton ranch, 25 feet southeast of intersection of old Phoenix Road with Oak Creek Road; iron post stamped "4354 PRSCT"	4,361.563
Briggs, 4.5 miles north of, 1.5 miles north of Lehman's mine, 40 feet east of road, on rocky point on ridge near divide; aluminum tablet stamped "4569 PRSCT"	4,576.486
Copperopolis mine, 1.1 miles north of, 125 feet east of trail, in point of rocky ridge; aluminum tablet marked "3939 PRSCT"	3,946.587
Briggs, 400 feet north of post office, 50 feet west of road, 15 feet higher than creek bed; aluminum tablet stamped "2759 PRSCT"	2,766.543

Briggs southeast to point 5.6 miles northwest of Hot Springs.

Briggs, 1.1 miles southeast of, north side of road at forks of road running to Whipsaw mine, foot of cliff on north side of Castle Creek; iron post stamped "2636 PRSCT"	2,643.779
Hot Springs, 5.6 miles northwest of, west side of Castle Creek, west side of road; iron post stamped "2350 PRSCT"	2,357.839

Hudson to Mayer.

Hudson, 500 feet northeast of abandoned house, north bank of creek, south side of road; iron post stamped "1931 PRSCT"	1,938.954
Goddard, 200 feet southeast of ranch, west side of road; iron post stamped "1991 PRSCT"	1,998.701
Black Canyon Creek, 50 feet south of, on point in bend of creek, 50 feet east of road; iron post stamped "2020 PRSCT"	2,027.742
Bumble Bee, 3 miles south of, 60 feet south of small dry creek, 10 feet east of road; iron post stamped "2515 PRSCT"	2,522.718
Bumble Bee, 200 feet northeast of store, 20 feet west of road; iron post stamped "2509 PRSCT"	2,516.822
Bumble Bee, 2.8 miles north of, 6 miles south of Cordes, in forks of road; iron post stamped "2686 PRSCT"	2,693.558
Cordes, 3 miles south of, in forks of road at Hidden Treasure mine, 20 feet west of road; iron post stamped "3074 PRSCT"	3,081.725
Cordes, 150 feet west of post office, 60 feet west of storehouse, 25 feet south of road; iron post stamped "3762 PRSCT"	3,769.793

	Feet.
Cordes, 2.5 miles north of, 6.5 miles south of Mayer, 10 feet east of road, on top of small raise; iron post stamped "4024 PRSCT"	4,031.641
Mayer, 3.25 miles south of, 30 feet east of road, on top of hill; iron post stamped "4353 PRSCT"	4,360.462

Mayer to Seven-Mile House.

Mayer, 0.3 mile north of railroad station, 25 feet west of road, 50 feet west of Big Bug Creek; iron post stamped "4392 PRSCT"	4,399.663
Mayer, 2.5 miles northwest of, 400 feet north of McMichael ranch, 180 feet west of railroad track, 20 feet northeast of road; iron post stamped "4605 PRSCT"	4,612.492
Old Big Bug Town, 1 mile north of Big Bug post office, in forks of Big Bug and McCabe Roads; iron post stamped "5069 PRSCT"	5,076.535
Providence, 0.8 mile northwest of post office, at forks in road to Postmaster mine; iron post stamped "5620 PRSCT"	5,627.816
Steeze ranch, 1.5 miles northwest of, on top of divide between Big Bug and Lynx Creeks; iron post stamped "6995 PRSCT"	7,002.972
Big Bug and Lynx Creek-Prescott roads, 1.25 miles northwest of intersection, on top of hill, 20 feet south of road; iron post stamped "6225 PRSCT"	6,232.685

Bueno to Mayer via Battle Flat.

Bueno, 5 miles east of, 2.25 miles west of Goat ranch, on bank of Tuscumbia Creek, 15 feet south of road; iron post stamped "5027 PRSCT"	5,034.718
Goat ranch, 0.5 mile northeast of, top of hill between Peck Canyon and Bear Creek, 15 feet east of road; iron post stamped "4638 PRSCT"	4,645.719
Wolf Creek, 1 mile northeast of, summit of hill between Wolf Creek and Dead Cow Gulch, slate outcrop 20 feet north of road; aluminum tablet stamped "4839 PRSCT"	4,846.535
Mayer, 1.5 miles southwest of, at forks of Crown King Road and old Virgin Mary Road; iron post stamped "4625 PRSCT"	4,632.648

Crown King to Alexandra.

Crown King, 2.25 miles north of, 4.8 miles south of Hooper post office, top of divide, 15 feet west of road; iron post stamped "6769 PRSCT"	6,776.240
Crown King, 75 feet north of saloon at intersection of Prescott-Crown King and Mayer-Crown King Roads, 25 feet north of Prescott Road; iron post stamped "5975 PRSCT"	5,082.631
Crown King, 3 miles north of, 0.5 mile north of top of divide, 20 feet west of road; iron post stamped "7016 PRSCT"	7,023.302
Alexandra, 3.8 miles north of top of divide, 8 feet north of road, in quartz rock; aluminum tablet stamped "5391 PRSCT"	5,398.769

Mount Union (not checked).

Mount Union, highest point; bronze tablet marking primary triangulation station, stamped "7971 PRSCT"	7,978.240

Bench mark 5 miles west of Minnehaha.

Minnehaha, 5 miles west of, 50 feet east of intersection of Wagoner, Minnehaha, and Briggs roads; iron post stamped "3955 PRSCT"	3,962.454

Bench mark at Chaparral siding.

	Feet.
Chaparral siding, 100 feet west of, 150 feet east of road; iron post stamped "4740 PRSCT"	4,747.018

NEW RIVER QUADRANGLE.

Point 2 miles northwest of Hot Springs to Alkire ranch.

Hot Springs, 2 miles northwest of, 30 feet south of Hot Springs Junction road, south side of Castle Creek; iron post stamped "2090 PRSCT"	2,098.084
Hot Springs, 20 feet east of hotel office; iron post stamped "1971 PRSCT"	1,970.721
Dripping Springs, 700 feet northwest of, foot of intersection of north bank of Castle Creek and west bank of ravine coming from east, 40 feet north of road; iron post stamped "1806 PRSCT"	1,813.752
Dripping Springs, 3.6 miles southeast of, foot of cliff, 15 feet high, north side of Castle Creek, 50 feet north of road; iron post stamped "1608 PRSCT"	1,615.536
Castle Creek, 275 feet northwest of mouth of, foot of north bank of Castle Creek, 50 feet east of rock ledge; iron post stamped "1489 PRSCT"	1,496.691
Agua Fria River, bed of, at road crossing	1,441
Frog Tank, 400 feet northwest of, on east side of river, 63 feet above river, west side of old road in rock ledge; aluminum tablet stamped "1495 PRSCT"	1,502.736
Lower New River, 6.8 miles southwest of, top of ridge between two small washes, 15 feet south of road; iron post stamped "1694 PRSCT"	1,701.801
Lower New River, 3.1 miles southwest of, 75 feet east of foot of bench on west side of New River, west side of trail; iron post stamped "1832 PRSCT"	1,839.902
Lower New River, southwest corner of yard, east side of road; iron post stamped "1984 PRSCT"	1,991.746
Alkire ranch, 10 feet north of yard gate, west side of road; iron post stamped "2155 PRSCT"	2,162.768

Nada siding southeast along Santa Fe, Prescott & Phoenix Ry. to Phoenix.

Nada, 3 miles south of, 60 feet west of track; iron post stamped "1574 PHNX"	1,573.579
Beardsley, 5.4 miles northwest of, 75 feet west of track, 0.5 mile southeast of mile board 163; iron post stamped "1451 PHNX"	1,451.097
Beardsley, 2.3 miles northwest of, 100 feet west of track; iron post stamped "1351 PHNX"	1,351.087
Beardsley, at section house yard gate, 75 feet east of track; iron post stamped "1282 PHNX"	1,282.184
Beardsley, 3.2 miles south of, 60 feet west of track, at mile board 172; iron post stamped "1189 PHNX"	1,189.098
Agua Fria River bridge, 24 feet above river bed; top of rail	1,139.2
Agua Fria River bridge, 0.1 mile east of, 40 feet east of track; iron post stamped "1151 PHNX"	1,151.108
New River bridge, 15 feet above river bed; top of rail	1,140.2
Peoria, 1.4 miles northwest of, 150 feet southeast of track at road crossing; iron post stamped "1136 PHNX"	1,136.150
Peoria, in front of station; top of rail	1,144.1

	Feet.
Peoria, 1.4 miles south of, 100 feet west of track at highway crossing; iron post stamped "1137 PHNX"	1,136.912
Glendale, north end of station park, east of track; iron post stamped "1152 PHNX"	1,152.423
Glendale, 2.2 miles east of, west of mile board 186, 100 feet north of track, by fence; iron post stamped "1144 PHNX"	1,144.252
Alhambra, in front wall of station; aluminum tablet stamped "1119 PHNX"	1,119.309
Six Points, 100 feet southeast of, where 6 roads intersect; iron post stamped "1082 PHNX"	1,081.458
Phoenix, Maricopa County courthouse, north front in projection of northwest corner; aluminum tablet stamped "1089 PHNX" (Phoenix datum tablet)	1,089.910

Point 2 miles north of Phoenix north along roads to New River.

Phoenix, 5.6 miles north of, 3 miles north of Six Points, 35 feet west of center of crossroads; iron post stamped "1135 PHNX"	1,134.784
Six Points, 6 miles north of, 75 feet east of cross roads; iron post stamped "1195 PHNX"	1,194.945
Arizona Canal, 2 miles north of, near west end of Phoenix Mountains, 25 feet west of road, iron post stamped "1287 PHNX"	1,286.742
Arizona Canal, 5 miles north of, 50 feet west of road; iron post stamped "1343 PHNX"	1,342.826
Arizona Canal, 8.1 miles north of, 0.5 mile southeast of Malpais Mountain, east side of road; iron post stamped "1403 PHNX"	1,402.791
Arizona Canal, 11.4 miles north of, 13 miles south of New River station, 30 feet west of road; iron post stamped "1480 PHNX"	1,479.413
New River station, 9.4 miles south of, 50 feet west of road; iron post stamped "1625 PHNX"	1,624.551
New River station, 5.8 miles south of, 25 feet east of road; iron post stamped "1705 PHNX"	1,704.404
New River station, 2.6 miles south of, east of road; iron post stamped "1910 PHNX"	1,909.713

The following bench marks were established by the Reclamation Service in 1902, 1903, and 1904:

North from Glendale to Arizona Canal, thence over Frog Tanks road and section line road to point 21.2 miles north of T. 4 N., R. 2 E., thence across desert to Agua Fria River, thence south to Agua Fria River bridge.

	Feet.
Glendale, north end of station, 50 feet east of Santa Fe, Prescott & Phoenix Ry. tracks; iron post stamped "1152 PHNX"	1,152.493
T. 3 N., R. 2 E., southeast corner of sec. 30, at southwest corner of crossroads; nail in root of large cottonwood tree	1,175.39
T. 3 N., R. 2 E., southeast corner of sec. 19, at southwest corner of crossroads; nail in root of cottonwood tree	1,184.06
Arizona Canal, 100 feet south of bridge, west side of public road; iron post stamped "1217 PHNX"	1,217.110
T. 4 N., R. 1 E., sec. 36; east quarter corner stone	1,237.85
T. 4 N., R. 1 E., sec. 25; southeast corner stone	1,248.05
T. 4 N., R. 1 E., east quarter corner of sec. 24; iron post stamped "1277 PHNX"	1,277.135

	Feet.
Augua Fria River, 850 feet west of wagon road, 150 feet east of giant cactus on edge of river, west side of road; iron post stamped "1267 PHNX"	1,266.803
Agua Fria River, 0.1 mile east of, Santa Fe, Prescott & Phoenix Ry. bridge, 40 feet east of track; iron post stamped "1151 PHNX"	1,151.352

Bench marks in sec. 7, T. 2 N., R. 2 E.

T. 2 N., R. 2 E., northwest corner of sec. 7, southeast corner of cross-roads; nail in root of large cottonwood tree	1,131.48
T. 2 N., R. 2 E., southwest corner of sec. 7, northwest corner of cross-roads, nail in root of cottonwood tree	1,122.44

Sec. 30, T. 3 N., R. 1 E., to point 0.36 mile north of south line of sec. 31, T. 3 N., R. 1 E.

T. 3 N., R. 1 E., sec. 30, south quarter corner stone	1,104.08
T. 3 N., R. 1 E., 0.36 mile north of south line of sec. 31 and 0.6 mile south of Desert road running west toward river; iron post stamped "1088 PHNX"	1,088.009

JEROME QUADRANGLE.

Prescott south 2.2 miles.

Prescott, 2.2 miles south of, at intersection of Crown King and Jersey Lily roads, 225 feet south of bridge over small gulch; iron post stamped "5543 PRSCT"	5,550.323

Bench marks near Four Mile House.

Seven Mile House, 0.2 mile southeast of, in forks of Lynx Creek, Prescott and Lynx Creek Dam roads; iron post stamped "5557 PRSCT"	5,564.346
Four Mile House, 150 feet northeast of, at junction of Prescott, Lynx Creek, and Black Canyon roads; iron post stamped "5565 PRSCT"	5,572.318

Prescott to Jerome Junction along Santa Fe, Prescott & Phoenix Ry.

Prescott, Prescott National Bank, south side of main entrance, top of southeast corner of square pedestal at foot of round column; flat surface	5,356.83
Prescott, 20 feet north of courthouse; iron post stamped "5346 PRSCT"	5,353.314
Prescott, 2.1 miles northeast of, 60 feet west of crossing of railroad by Mayer wagon road; iron post stamped "5248 PRSCT"	5,255.163
Prescott, 6.5 miles northeast of, 50 feet east of P. & E. Junction, 20 feet east of Prescott & Eastern branch track, granite rock 3 feet above track; aluminum tablet stamped "5125 PRSCT"	5,131.614
Prescott, 9.6 miles northeast of, 3.1 miles northeast of P. & E. Junction, 50 feet west of track at road crossing; iron post stamped "4942 PRSCT"	4,949.010
Prescott, 12.8 miles northeast of, 75 feet west of track at Granite, at middle of sidetrack; iron post stamped "4888 PRSCT"	4,895.108
Jerome Junction, 2.9 miles south of, 60 feet west of track, on small ridge; iron post stamped "4794 PRSCT"	4,800.732

	Feet.
Jerome Junction, 50 feet south of station, 25 feet east of Santa Fe, Prescott & Phoenix Ry. track; iron post stamped "4607 PRSCT"	4,613.833

Jerome Junction to Jerome along United Verde & Pacific Ry.

Jerome Junction, 2.9 miles east of, 75 feet north of railroad, on ridge; iron post stamped "4763 PRSCT"	4,769.772
Jerome Junction, 5.9 miles east of, 75 feet northeast of crossing of railroad by wagon road, 25 feet northeast of road intersection; iron post stamped "4874 PRSCT"	4,880.856
Davis, 50 feet southeast of, wagon road crossing; iron post stamped "5114 PRSCT"	5,120.653
Summit, 125 feet west of section house, 90 feet west of track; iron post stamped "5491 PRSCT"	5,497.619
Bodkin, 300 feet north of track, near end of Malpais Ridge; bronze tablet stamped "5424 PRSCT"	5,431.257
Horseshoe, 125 feet south of head block, 75 feet west of and 30 feet higher than track, limestone ledge; bronze tablet stamped "5821 PRSCT"	5,827.893
First View, 50 feet south of track; iron post stamped "5931 PRSCT"	5,937.766
Jerome, 2.7 miles northwest of, 500 feet north of section house, 75 feet east of track where it turns through limestone cut; bronze tablet stamped "5805 PRSCT"	5,811.723
Chris spur, 200 feet east of railroad, limestone ledge; bronze tablet stamped "5669 PRSCT"	5,675.329
Jerome, southeast corner of United Verde Copper Co.'s building (office), 8 inches above ground; aluminum tablet stamped "5428 PRSCT"	5,435.169

Davis, United Verde & Pacific Ry., southeast to Carter ranch, thence northeast via Yaeger Canyon to Jerome.

Davis, 3 miles south of, 20 feet south of road; iron post stamped "5185 PRSCT"	5,191.614
Carter ranch, 1.9 miles west of, 6.2 miles southeast of Davis, 25 feet north of road in forks of wash; iron post stamped "5430 PRSCT"	5,436.723
Carter ranch, northwest corner of yard fence, north side of road; iron post stamped "5763 PRSCT"	5,769.631
Sanders station, 2.9 miles northeast of; top of divide on Jerome and Prescott road, north side of road; iron post stamped "7025 PRSCT"	7,031.592
Mescal, 400 feet south of abandoned station, 50 feet west of road, ledge of limestone rock, bronze tablet stamped "6232 PRSCT"	6,238.635
Mescal, 0.5 mile north of abandoned station, 20 feet east of road at top of divide; bronze tablet stamped "6504 PRSCT"	6,510.356
Mescal, 2.2 miles north of, 120 feet east of road; iron post stamped "6473 PRSCT"	6,479.635
Jerome, 1.1 miles west of, top of Smelter Hill, where road passes through top of ridge, 120 feet east of road; bronze tablet stamped "6269 PRSCT"	6,275.412
Jerome, 0.5 mile south of, summit of Red Hill above smelter, 1,000 feet east of converter pipe, 3 feet east of rock monument; bronze tablet stamped "6052 PRSCT"	6,058.470

Carter ranch south to Dewey.

	Feet.
Carter ranch, 2.5 miles south of, 100 feet south of intersection of Prescott, Jerome, and Dewey Roads; iron post stamped "5331 PRSCT"	5,337.640
Carter ranch, 5.3 miles south of, 25 feet west of road; iron post stamped "4979 PRSCT"	4,985.697
Dewey, 2.3 miles north of, 75 feet north of intersection of roads, 0.3 mile south of deserted ranch; iron post stamped "4686 PRSCT"	4,692.381
Dewey post office, Cherry Creek railroad station, 50 feet north of Hiltonbrandt house, by fence; iron post stamped "4548 PRSCT"	4,554.667

Dewey west along Lynx Creek wagon road to Prescott.

Thomas ranch, 300 feet northwest of, 60 feet northeast of railroad crossing; iron post stamped "4652 PRSCT"	4,658.765
Thomas ranch, 4.1 miles northwest of, 30 feet south of road, at top of hill; iron post stamped "5126 PRSCT"	5,132.863
Lynx Creek, west bank of, 150 feet north of schoolhouse, 25 feet south of road; iron post stamped "5287 PRSCT"	5,293.905
Four Mile House, 150 feet northeast of, junction of Lynx Creek, Prescott and Black Canyon Roads; iron post stamped "5565 PRSCT"	5,572.118

Mescal station (abandoned) down Mescal Canyon to abandoned sawmill, thence along trail on northwest side of Mescal Canyon via Legal Tender and Grand Prize shafts to E. L. D. shaft.

Mescal station, 0.8 mile east of, 200 feet north of abandoned sawmill, 75 feet west of cabin, 60 feet north of trail, top of ledge of sandstone; bronze tablet stamped "6085 PRSCT"	6,091.644
Mescal station, 1.6 miles northeast of, east side of mountain, highest point of red rock ridge, 100 feet east of trail and E. L. D. shaft; bronze tablet stamped "6011 PRSCT"	6,018.001

Jerome along wagon road to Cottonwood.

Jerome, northeast corner of T. F. Miller's store, 2 feet above sidewalk; aluminum tablet stamped "5153 PRSCT"	5,159.823
Jerome, 50 feet east of fork of road to cemetery and slaughterhouse, top of ridge near east end; iron post stamped "4887 PRSCT"	4,893.759
Jerome, at point where road strikes bottom of Deception Gulch (Walnut Gulch) in going from Jerome to Verde River, large bowlder 100 feet north of creek, on southwest side of road; bronze tablet stamped "4743 PRSCT"	4,750.055
Hinman's blacksmith shop, 0.5 mile east of, 100 feet southwest of road intersection; iron post stamped "3930 PRSCT"	3,936.962
Cottonwood post office (Strahan's store), 125 feet south of, 15 feet east of road; iron post stamped "3315 PRSCT"	3,321.761
Van Derien ranch, 150 feet west of, 75 feet northwest of road fork; iron post stamped "3276 PRSCT"	3,282.635

Cherry post office west along wagon road to Dewey.

Cherry post office, 3 miles east of, top of ridge overlooking Verde Valley, 40 feet north of road, granite outcrop; bronze tablet stamped "4817 PRSCT"	4,824.155

	Feet.
Cherry post office (Battye ranch), 75 feet southwest of road by fence; iron post stamped "5004 PRSCT"	5,011.102
Cherry, 2.2 miles west of, top of divide, 25 feet south of road; iron post stamped "5441 PRSCT"	5,447.910
Martin ranch, 2.8 miles east of, top of ridge, 25 feet north of road; iron post stamped "4776 PRSCT"	4,783.217
Martin Rust ranch, west side of road by corral fence; iron post stamped "4704 PRSCT"	4,711.129
Dewey, 3.7 miles east of, top of divide, 25 feet south of road; iron post stamped "5066 PRSCT"	5,073.010

Jerome Junction north along Santa Fe, Prescott & Phoenix Ry. to Putney's limekiln road.

Jerome Junction, 2.6 miles north of, 110 feet west of railroad, west side of wagon road, near corner of fence and mileboard 36; iron post stamped "4507 PRSCT"	4,513.946
Del Rio, 0.2 mile north of water tank, 45 feet east of railroad at road crossing, south side of wagon road; iron post stamped "4384 PRSCT"	4,390.940
Del Rio, 1 mile north of, Verde River, railroad bridge, 55 feet above river bed; top of rail	4,365.6
Del Rio, 2.7 miles north of, 50 feet west of railroad, 50 feet east of wagon road, about level with track; iron post stamped "4400 PRSCT"	4,406.752
Del Rio, 5.1 miles northeast of, 1 mile northeast of Valley siding, 100 feet north of track, north side of road; iron post stamped "4495 PRSCT"	4,501.923

SANTA MARIA MOUNTAINS QUADRANGLE.

Point near Prescott on old stage road to Government Spring.

Prescott, 2.7 miles west of, top of small ridge, 50 feet south of road, granite bowlder 3 feet in diameter; aluminum tablet stamped "5745 PRSCT"	5,752.045

Prescott along Simmons road to American ranch, thence along California stage road via Tonto Spring to Skull Valley.

Prescott, 3 miles northwest of, 100 feet north of railroad, 150 feet northwest of road fork, granite bowlder 3 feet high; aluminum tablet stamped "5545 PRSCT"	5,552.359
Blair ranch, 1.4 miles north of, 25 feet west of road, on top of ridge; iron post stamped "5484 PRSCT"	5,491.160
American ranch, 2.6 miles southeast of, 25 feet north of road, on ridge; iron post stamped "5228 PRSCT"	5,234.932
American ranch, 0.8 mile north of, 25 feet east of fork of road, on ridge; iron post stamped "5049 PRSCT"	5,056.369
Hull ranch, 2.5 miles west of, summit of granite range, 25 feet south of road; iron post stamped "5540 PRSCT"	5,547.256
Tonto Spring, 3.6 miles northeast of, 0.5 mile east of Skull Valley and Williamson Valley Road, 250 feet north of road, in malpais rock 4 feet square and 3 feet high; bronze tablet stamped "5151 PRSCT"	5,157.919

	Feet.
Tonto Spring, 0.5 mile northeast of, 100 feet northwest of road fork, at foot of granite ledge near its center; bronze tablet stamped "4856 PRSCT"	4,863.150
Tonto Spring, 2.9 miles south of, 40 feet east of road fork; iron post stamped "4732 PRSCT"	4,739.135
Dixon ranch, 1 mile northeast of, 25 feet west of road; iron post stamped "4484 PRSCT"	4,490.969
Dixon ranch, 0.5 mile southeast of, 300 feet southwest of main road, 75 feet south of road to Dixon ranch, granite bowlder 5 feet in diameter and 2 feet high; aluminum tablet stamped "4382 PRSCT"	4,388.925
Skull Valley, 450 feet southwest of railroad station, west side of road, by fence; iron post stamped "4250 PRSCT"	4,256.962

Santa Fe, Prescott & Phoenix Ry. west along Putney's limekiln road to King's ranches, thence south via Simmons to a point 3.6 miles north of Tonto Springs.

Putney ranch, 0.6 mile southeast of, in forks of road; iron post stamped "4385 PRSCT"	4,391.920
King's lower ranch, 30 feet west of main gate, south side of road along side of east and west section lines, at fence; iron post stamped "4414 PRSCT"	4,420.864
King's lower ranch, 2.1 miles west of, 25 feet southwest of cross-roads; iron post stamped "4470 PRSCT"	4,476.630
King's upper ranch, 1 mile northwest of, east end of prominent ridge, south of Walnut Creek, about 0.5 mile west of creek in China Valley, about 0.7 mile northeast of east end of cedar ridge, 300 feet west of road; iron post stamped "4524 PRSCT" (checked spur line)	4,530.888
King's lower ranch, 5.6 miles southwest of, 6.9 miles northwest of Simmons, 25 feet west of road on ridge, near a ridge covered with scattering cedar timber; iron post stamped "4632 PRSCT"	4,638.798
Sullivan ranch, 0.7 mile northwest of lower house, 3.7 miles north of Simmons, 25 feet west of road in small valley between two cedar ridges; iron post stamped "4529 PRSCT"	4,535.607
Simmons, 100 feet west of post office, south side of road by fence; iron post stamped "4542 PRSCT"	4,548.565
Stephens ranch, by yard fence, east of gate; iron post stamped "4615 PRSCT"	4,621,326
Stephens ranch, 2.3 miles south of, 125 feet southeast of road at gate near foot of malpais ridge; aluminum tablet stamped "4690 PRSCT"	4,696.563
Stephens ranch, 3.6 miles south of, 20 feet west of road at gate in Stephens ranch south fence; iron post stamped "4738 PRSCT"	4,745.166

Stephens ranch west along wagon and Simmons-Kymo road to Kymo, thence north along Cut-Off Road and northeast along Walnut Creek to Jumper, thence east to point 6.9 miles north of Simmons.

Cook ranch, 3 miles west of, 3.1 miles southeast of Humphrey ranch, 20 feet north of road on ridge at east side of big wash; iron post stamped "4702 PRSCT"	4,708.427

	Feet.
Humphrey ranch, 0.5 mile southeast of, 30 feet west of forks of Simmons Road; iron post stamped "4755 PRSCT"	4,761.924
Humphrey ranch, 2.4 miles northwest of, 20 feet west of road near where road starts up hill; iron post stamped "4887 PRSCT"	4,893.868
Kymo, 5.3 miles east of, 80 feet north of road on high ridge east of Pine Flat; iron post stamped "6039 PRSCT"	6,045.959
Pine Flat, 0.5 mile northwest of cabin, 20 feet south of road; iron post stamped "5708 PRSCT"	5,714.724
Kymo post office (Ferguson ranch), 2 feet northwest of house, north side of road; iron post stamped "5888 PRSCT"	5,894.651
Conger ranch, 0.5 mile south of, east side of road on top of divide; iron post stamped "6090 PRSCT"	6,096.603
Warren ranch, north side of yard gate, 125 feet northeast of road; iron post stamped "6244 PRSCT"	6,250.693
Warren ranch, 2 miles northwest of, top of divide at head of Walnut Creek watershed, 50 feet south of road; iron post stamped "6346 PRSCT"	6,352.652
Hamilton ranch, 1.8 miles northwest of, 50 feet west of road in granite ledge crossing road and creek at right angles; aluminum tablet stamped "5773 PRSCT"	5,779.599
Drew ranch, 1 mile west of, 100 feet west of the forks of the Juniper Canyon and Camp Woods Road; iron post stamped "5495 PRSCT"	5,501.622
Connell ranch, 0.2 mile northwest of, north side of road in granite bowlder; aluminum tablet stamped "5343 PRSCT"	5,349.739
Juniper, 50 feet northeast of post office, south side of road; iron post stamped "5158 PRSCT"	5,164.851
Rogers ranch, north side of yard gate, north side of road; iron post stamped "4983 PRSCT"	4,989.528
Rogers ranch, 2.7 miles southeast of, 25 feet north of road in gulch; iron post stamped "4881 PRSCT"	4,887.437
Rogers ranch, 6.5 miles southeast of, 25 feet east of road on top of ridge, 0.5 mile south of where road leaves gulch; iron post stamped "4693 PRSCT"	4,699.407

CAMP VERDE QUADRANGLE.

Cottonwood down Verde River Road via Oak Creek and Aultman to Cherry.

Oak Creek, 1.5 miles north of mouth of, 1,500 feet east of Verde River, 40 feet east of road; iron post stamped "3243 PRSCT"	3,249.848
Verde River at mouth of Oak Creek; surface of	3,176
Aultman, 0.5 mile west of store, 500 feet west of Marr ranch, 75 feet south of road; iron post stamped "3183 PRSCT"	3,189.665
Marr ranch, 3.1 miles west of, 40 feet north of intersection of Autlman, Cherry, and Camp Verde roads; iron post stamped "3616 PRSCT"	3,622.857

CONGRESS QUADRANGLE.

Skull south along Santa Fe, Prescott & Phoenix Ry. via Kirkland, Hillside, and Martinez to Wickenburg.

Wilson ranch, 950 feet north of railroad crossing; iron post stamped "4112 PRSCT"	4,119.277

	Feet.
Kirkland, in front of Earnhart house, east side of road; iron post stamped "3927 PRSCT"	3,934.203
Robinson ranch, east side of yard gate, south side of road, iron post stamped "3825 PRSCT"	3,832.317
Grand View, 0.6 mile north of, 50 feet north of track at mileboard 93, near beginning of north side of loop, malpais rock 3 feet in diameter and 18 inches high; aluminum tablet stamped "4084 PRSCT"	4,090.982
Hillside, 3.9 miles east of, 75 feet north of track where railroad runs through cut, east of Bog Curve, 700 feet west of trestle 172; aluminum tablet stamped "4123 PRSCT"	4,130.580
Hillside, east end of railway station, at end of platform; iron post stamped "3845 PRSCT"	3,852.433
Hillside, 2.4 miles south of, 0.3 mile northwest of mileboard 104, 75 feet west of track; iron post stamped "3754 PRSCT"	3,761.303
Date Creek, 2.2 miles north of, west side of railroad at deep cut, 0.1 mile north of mileboard 107, iron post stamped "3584 PRSCT"	3,590.989
Date Creek, 0.2 mile south of section house, 150 feet west of railroad, 50 feet west of wagon road, on ridge 15 feet higher than track; iron post stamped "3367 PRSCT"	3,374.339
Date Creek, 3 miles south of, 0.1 mile north of bridge 197, on top of hill 100 feet west of track, 250 feet east of wagon road, iron post stamped "3286 PRSCT"	3,293.170
Piedmont, 0.1 mile north of north head block, 75 feet east of wagon road, 150 feet east of track, top of small hill; iron post stamped "3345 PRSCT"	3,352.294
Martinez, 250 feet north of Congress pumphouse, west side of railroad at mileboard 119, lower part of granite ledge; aluminum tablet stamped "3183 PRSCT"	3,189.894
Congress Junction, 1.6 miles north of, 60 feet south of railroad between a gravel cut and a rock cut, east of trestle 223, top of granite bowlder below level of track; aluminum tablet stamped "3094 PRSCT"	3,101.294
Congress Junction, 0.3 mile north of station, 60 feet northwest of railroad crossing; iron post stamped "3032 PRSCT"	3,039.153
Congress Junction, 3.3 miles south of, 50 feet east of railroad; iron post stamped "2825 PRSCT"	2,832.558
Harquahala siding, 0.1 mile south of, 160 feet southwest of track at road crossing; iron post stamped "2595 PRSCT"	2,602.859
Harquahala siding, 3.4 miles south of, 160 feet west of railroad at mileboard 133; iron post stamped "2384 PRSCT"	2,391.776
Wickenburg, 2.7 miles northwest of, 150 feet west of railroad at Yavapai and Maricopa County line; iron post stamped "2171 PRSCT"	2,178.839

Congress Junction southwest to Gibsons tank, thence southeast 6 miles, thence east to Harquahala.

Congress Junction, 2.5 miles west of, 30 feet north of road; iron post stamped "2933 PRSCT"	2,940.394
Congress Junction, 5.3 miles west of, 60 feet southeast of crossroads; iron post stamped "2783 PRSCT"	2,790.157

	Feet.
Congress Junction, 7.1 miles west of, 30 feet south of road at forks of road, 0.8 mile east of Gibson's tank; iron post stamped "2728 PRSCT"	2,735.387
Gibson's tank, 4 miles southeast of, 0.3 mile northeast of southeast end of small mountain range, 25 feet south of road; iron post stamped "2606 PRSCT"	2,613.520
Gibson's tank, 6 miles southeast of, 3.6 miles west of Harquahala siding, 50 feet east of old road; iron post stamped "2637 PRSCT"	2,644.438

Kirkland southeast to Onyx quarry.

Kirkland, 1.5 miles southeast of, 100 feet northwest of fork of Stanton and Walnut Grove Road, black rock cliff; aluminum tablet stamped "3972 PRSCT"	3,979.026
Kirkland, 2.9 miles southeast of, 85 feet northwest of fork of Placerita and Walnut Grove Road; iron post stamped "4060 PRSCT"	4,067.400

Prescott west via Government Spring, Onyx quarry, Walnut Grove, and Wagoner to Campbell ranch.

Government Spring, 0.5 mile east of, 100 feet east of top of divide, 40 feet north of road, granite rock 3 feet high; bronze tablet stamped "6775 PRSCT"	6,782.663
Copper Basin, 0.3 mile east of, 30 feet north of road; iron post stamped "5316 PRSCT"	5,323.223
Copper Basin, 3 miles south of, foot of hill, west side of Copper Creek, 250 feet southwest of wagon road, northeast end of gray bowlder 15 feet long and 4 feet high; bronze tablet stamped "4740 PRSCT"	4,747.626
Onyx mine, 4.3 miles northeast of, top of ridge, 20 feet west of road; iron post stamped "4955 PRSCT"	4,962.227
Onyx mine, 0.8 mile east of, 300 feet north of fork of Kirkland and Copper Basin Road, granite bowlder 4 feet long and 1 foot high; aluminum tablet stamped "4556 PRSCT"	4,563.310
Moor ranch, 1.8 miles north of, west side of road, on ridge; iron post stamped "4170 PRSCT"	4,177.069
Craig post office, 200 feet north of, north side of road; iron post stamped "3764 PRSCT"	3,771.489
Moor lower ranch, 0.2 mile south of, top of ridge, 20 feet west of road; iron post stamped "3589 PRSCT"	3,596.479
Walnut Grove post office, 10 feet east of yard gate, south side of road; iron post stamped "3469 PRSCT"	3,476.603
Wagoner post office, 150 feet north of east side of yard gate; iron post stamped "3372 PRSCT"	3,379.585
Campbell ranch, 200 feet west of, east side of road; iron post stamped "3485 PRSCT"	3,492.572

WICKENBURG QUADRANGLE.

Wickenburg southeast along Santa Fe, Prescott & Phoenix Ry. to Nada.

Wickenburg, 300 feet north of station, 50 feet east of track at railroad restaurant; iron post stamped "2068 PRSCT"	2,075.764
Wickenburg, in front of station; top of rail	2,070

	Feet.
Wickenburg, 1.7 miles south of, 75 feet northwest of track at road crossing; iron post stamped "2004 PHNX"	2,003.905
Wickenburg, 5 miles south of, 50 feet west of track, 0.3 mile south of mile board 144; iron post stamped "1935 PHNX"	1,934.800
Hassayampa River, railroad bridge over, 33 feet above river bed; top of rail	1,858
Hot Springs Junction, 3 miles north of, 75 feet east of track, 0.2 mile south of bridge over Hassayampa River; iron post stamped "1865 PHNX"	1,864.754
Hot Springs Junction, in hotel yard, 75 feet east of track; iron post stamped "1971 PHNX"	1,970.841
Hot Springs Junction, 3.4 miles south of, 50 feet west of track, 0.5 mile south of mile board 153; iron post stamped "1883 PHNX"	1,882.992
Nada, 25 feet east of signboard; iron post stamped "1697 PHNX"	1,696.333

Camels Back, Fort McDowell, Livingstone, and Roosevelt Quadrangles.

MARICOPA AND GILA COUNTIES.

The elevations in the following list were originally based on an aluminum tablet stamped "1090" set in the north front of the Maricopa County courthouse at Phoenix, and accordingly all bench marks are stamped "PHNX" in addition to the figures of elevation. The corrected elevation of this bench mark is 1,089.910 feet above mean sea level.

The leveling was done in 1905 by Ress Philips.

CAMELS BACK QUADRANGLE.

Point 7 miles northeast of Phoenix to point 10.5 miles west of Asher ranch.

	Feet.
Phoenix, 7 miles northeast of, 50 feet northeast of crossroads, at southwest corner of fence; iron post stamped "1197 PHNX"	1,196.879
Phoenix, 9 miles northeast of, 0.5 mile north of Arizona Canal, 30 feet west of road; iron post stamped "1282 PHNX"	1,281.705
Phoenix, 13 miles northeast of, at junction of Cave Creek and Camp Creek roads; iron post stamped "1455 PHNX"	1,454.818
Phoenix, 16 miles northeast of, 0.75 mile west of old canal, 30 feet north of road; iron post stamped "1495 PHNX"	1,494.446
Desert Corral, 30 feet north of road; iron post stamped "1631 PHNX"	1,630.394
Desert Corral, 0.75 mile west of, forks of Camp Creek and Tempe roads, 20 feet north of road, near large mesquite tree; iron post stamped "1892 PHNX"	1,891.320
Desert Corral, 6 miles northeast of, 30 feet north of road on bank of ravine running parallel with road; iron post stamped "2204 PHNX"	2,203.338
Desert Corral, 9 miles northeast of, at point where road crosses deep, dry wash, 120 feet south of bottom of wash, 60 feet east of road, in bowlder; aluminum tablet stamped "2486 PHNX"	2,485.618
Asher ranch, 12.5 miles west of, on summit of low divide between Cave Creek and Verde River, 10 feet north of old road, in ledge; aluminum tablet stamped "2945 PHNX"	2,944.366

The following bench marks were established by the Reclamation Service in 1902, 1903, and 1904:

FORT McDOWELL QUADRANGLE.

Point 3.7 miles southeast of Arizona Dam to head gate of Arizona Canal.

	Feet.
Arizona Dam, 3.7 miles southeast of, at power house, in bridge over Arizona Canal; top of bolt	1,311.77
Head gate of Arizona Canal, northwest abutment; top of coping	1,329.85

Between the first and second of the following bench marks four lines were run, and from the fourth to the ninth, inclusive, two lines were run by I. J. Voorhees, but they depend on and are connected by a single line run in 1902 by R. E. Whipfler between points 3.7 miles below and 3.5 miles above Arizona Dam. The third and the Verde Dam site bench marks are on single-spur lines from the second:

Arizona Dam up Salt River northeast to Verde River, thence east up Salt River to Tonto Dam site.

	Feet.
Arizona Dam, in top of masonry wing of Arizona Canal head gates; bronze tablet stamped "1330 PHNX"	1,329.875
Arizona Dam, 0.7 mile northeast of, west of mouth of Verde River and north side of Salt River, on south side of road from Frazers to Cuba, south of large red butte and at west end of small red butte; bronze tablet stamped "1343 PHNX"	1,343.608
Arizona Dam, 1.5 miles northeast of, on road from Usery Pass to Cuba and Fort McDowell, about 450 feet west of ford in front of large red cliff, facing Salt River, 0.7 mile above its junction with Verde River, on rock ledge running out to river; bronze tablet stamped "1340 PHNX"	1,340.649
Arizona Dam, 4 miles east of, 600 feet northwest of Monroy ranch house, on granite ledge between river and high bluff, in rock; bronze tablet stamped "1382 PHNX"	1,382.381
Arizona Dam, 6.9 miles east of, on right bank of river near high, blue bluff, locally known as "Blue Point," facing river, in rock; bronze tablet stamped "1384 PHNX"	1,384.547
Arizona Dam, 10.4 miles east of, on right bank of Salt River about midway between Canyon No. 1 and Canyon No. 2, about 1.5 miles below Stewart ranch, in granite outcrop; bronze tablet stamped "1434 PHNX"	1,434.444

Point 9.75 miles west of Asher ranch to point 9.5 miles south of McDowell.

Asher ranch, 9.75 miles west of, on south bank of wash where road crosses to right, 40 feet east of road, in bowlder; aluminum tablet stamped "2600 PHNX"	2,599.479
Asher ranch, 5.25 miles west of, 5 miles west of Verde River, at forks of roads, 10 feet west of road on north side of wash; iron post stamped "2175 PHNX"	2,174.400
Asher ranch, 3 miles west of, 2.25 miles west of Verde River road, 10 feet north of road; iron post stamped "1859 PHNX"	1,858.442

	Feet.
Asher ranch, 0.5 mile northwest of, at crossroads; iron post stamped "1572 PHNX"	1,570.405
Asher ranch, 4 miles south of, in forks of road at foot of hill; iron post stamped "1488 PHNX"	1,487.647
McDowell, 500 feet southeast of post office, at northeast corner of fence, 10 feet west of road; iron post stamped "1444 PHNX"	1,443.410
McDowell, 4 miles south and east of, 0.5 mile east of ford, on road from Phoenix to Reno Pass, at mouth of dry wash, at north end of small rocky ridge, in bowlder; aluminum tablet stamped "1424 PHNX"	1,423.214
McDowell, 6.25 miles south of, 400 feet south of old schoolhouse, 200 feet south of road, at foot of hill, in bowlder; aluminum tablet stamped "1402 PHNX"	1,401.724
McDowell, 9.5 miles south of, south side of Salt River 0.5 mile above its junction with Verde River, 500 feet west of old ford on road to Cuba and Fort McDowell, near large bluff, on point running out into river; bronze tablet stamped "1340 PHNX"	1,340.049

Fort McDowell east along Reno Pass Road to Clanton ranch, thence south to Roosevelt. (Closure error excessive.)

McDowell, 4.75 miles east of, 500 feet northeast of Adams ranch house, 100 feet northeast of corral, on hillside 150 feet west of road, in bowlder; aluminum tablet stamped "1540 PHNX"	1,539.561
McDowell, 7.75 miles east of, 3 miles east of Adams ranch, 20 feet north of road; iron post stamped "1643 PHNX"	1,642.632
McDowell, 11.75 miles east of, on west side of and at foot of Sugar Loaf Mountain, at point where wagon road crosses creek, 50 feet east of road on west bank of creek, 250 feet east of old corral, in large bowlder; aluminum tablet stamped "1786 PHNX"	1,785.453
McDowell, 14 miles east of, 1 mile north of point where road leaves creek, 50 feet west of road, on west bank of wash, in bowlder; aluminum tablet stamped "2214 PHNX"	2,213.208

ROOSEVELT QUADRANGLE.

Point 14.75 miles northeast of McDowell to Roosevelt.

McDowell, 16.75 miles northeast of, 1 mile east of divide, 200 feet south of point where road enters large wash, 15 feet east of road, 40 feet northeast of large willow tree, in bowlder; aluminum tablet stamped "2188 PHNX"	2,187.436
Oteros ranch, on south side of corral, 200 feet north of house, in root of dead sycamore tree; nail	2,136.671
Oteros ranch, 1.5 miles northeast of, on south bank of Sycamore Creek, on north end of high black bluff reaching down to water; aluminum tablet stamped "2202 PHNX"	2,202.583
Round Valley, north side of, 500 feet north of point where wagon road crosses Sycamore Creek, 300 feet north of old house and corral, 20 feet south of road, top of small mesa, in top of granite bowlder; aluminum tablet stamped "2369 PHNX"	2,368.983
Round Valley, 3.5 miles northeast of, 5 feet east of road, on top of long grassy ridge, in bowlder; aluminum tablet stamped "3270 PHNX"	3,269.734

	Feet.
Sunflower ranch, 1.25 miles west of, 400 feet east of summit where wagon road crosses highest point between Round Valley and Sunflower ranch, 20 feet north of road at foot of rocky ridge, in bowlder; aluminum tablet stamped "3780 PHNX"	3,779.986
Sunflower ranch, south side of, on west bank of Sycamore Creek, 500 feet east of gate to ranch, 10 feet north of road, in root of sycamore tree; nail	3,409.370
Sunflower ranch, 1 mile south of, 0.25 mile east of Sycamore Creek, where road crosses ridge on north side of rocky butte, 100 feet south of road on summit, on large bowlder; aluminum tablet stamped "3435 PHNX"	3,434.814
Reno Pass, on summit, 50 feet south of and 15 feet above wagon road, in ledge; aluminum tablet stamped "4723 PHNX"	4,722.944
Moore ranch, 0.5 mile west of, 15 feet north of road, on rocky slope at mouth of canyon; aluminum tablet stamped "2869 PHNX"	2,869.018
Moore ranch, 2.5 miles east of, 1 mile north of Clanton ranch, 0.5 mile south of perpendicular clay bank 700 feet high, 0.5 mile west of Tonto Creek, 50 feet west of old Reno Pass road, at east end of small ridge, in west edge of valley, in bowlder; aluminum tablet stamped "2355 PHNX"	2,354.621
Clanton ranch, 1 mile north of, on west side of Tonto Creek, 250 feet northwest of ford, in large cottonwood tree; nail	2,310.228
Clanton ranch, 2 miles north of, in road opposite deserted farm house, in base of sycamore tree; nail	2,333.747
Clanton ranch, 4 miles north of, on mesa 30 feet east of road, 500 feet north of wash, on bowlder; aluminum tablet stamped "2422 PHNX"	2,420.737
Clanton ranch, 5.25 miles north of, 30 feet east of road, in base of ironwood stump; nail	2,420.865
Howell ranch, 100 feet east of old Tonto post office, 30 feet east of road; iron post stamped "2488 PHNX"	2,487.851
Clanton ranch, in front of house 20 feet west of road, inside fence corner; iron post stamped "2300 PHNX"	2,300.026
Clanton ranch, 3 miles south of, 300 feet east of ford, 50 feet east of road, at foot of steep bank, on east side of old irrigating ditch, in bowlder; aluminum tablet	2,235.30
Cline post office, 400 feet east of, 30 feet west of road at fence corner; iron post stamped "2191 PHNX"	2,191.003
Cline station, 300 feet south of, 15 feet west of road, in root of ironwood stump 8 feet high; nail	2,190.906
Cline station, 1.5 miles south of, 30 feet west of road, on smooth, level mesa, in buried stone 8 by 12 inches by 2 feet; aluminum tablet stamped "2197 PHNX"	2,197.325
Cline station, 3.75 miles south of, east side of Botticher ranch at gate 30 feet west of road; iron post stamped "2093 PHNX"	2,092.683
Botticher ranch, 2 miles south of, 5 miles north of Roosevelt, 10 feet east of road, in stone flush with ground; aluminum tablet stamped "2028 PHNX"	2,027.715
Roosevelt, 3 miles north of, foot of hill, 20 feet east of road, in bowlder; aluminum tablet stamped "1991 PHNX"	1,991.551
Roosevelt, 1.5 miles north of, 100 feet north of forks of road, 50 feet north of fence corner, in base of cottonwood stump; nail	1,946.714
Roosevelt, east entrance of power house, 1 foot from east wall; iron post stamped "1986 PHNX"	1,985.416

Point 3.5 miles northeast of Government Well to point 20.2 miles east of Arizona Dam.

	Feet.
Government Well, 3.5 miles northeast of, 250 feet northeast of Camp Lonely, 20 feet east of road, in ledge; aluminum tablet stamped "2138 PHNX"	2,138.221

The following bench marks were established by the Reclamation Service in 1902, 1903, and 1904:

Point 12.8 miles east of Arizona Dam to Verde Dam site at Verde River.

	Feet.
Arizona Dam, 12.8 miles east of, on right bank of Salt River 0.75 mile above Stewart ranch in Canyon No. 2, 250 feet from river bank, in rock ledge; bronze tablet	1,490.981
Arizona Dam, 16.2 miles east of, on left bank of Salt River, 50 feet from water edge, in mouth of Canyon No. 3, at upper end of Bagley Flat, on large white granite outcrop; bronze tablet stamped "1492 PHNX"	1,492.362
Mormon Flat, 20.2 miles east of Arizona Dam, on right bank of Ash Creek 600 feet above its junction with Salt River, 90 feet northeast of large cottonwood tree on left bank of Ash Creek, set vertically in solid rock; bronze tablet stamped "1547 PHNX"	1,546.915

At Verde River.

Verde Dam site, at right bank of river in rock; bronze tablet stamped "1337 PHNX"	1,336.702

Roosevelt east to mouth of Grapevine Tunnel (bench marks of Reclamation Service.)

Roosevelt, east bank of river at dam site; brass tablet marked "1908 PHNX," cemented vertically in rock at center line of borings	1,908.041
Roosevelt, west bank of river at dam site; brass tablet stamped "1905 PHNX," cemented vertically in rock at center line of borings	1,905.211
Roosevelt, northwest corner of boiler room of temporary power house, 1 foot from north wall; iron post stamped "1986 PHNX"	1,986.016
Roosevelt, 5 miles east of, on Windy Hill Divide, top of east bank of first canyon east of Porter Springs, 500 yards south of road; iron post stamped "2160 PHNX"	2,160.067
Roosevelt, 8 miles east of, at mouth of Grapevine Tunnel, power canal line; iron post stamped "2174 PHNX"	2,174.120

LIVINGSTONE QUADRANGLE.

Mouth of Grapevine Tunnel east to Livingstone (bench marks of Reclamation Service.)

Roosevelt, 12 miles east of, east bank of Chilton Canyon, beside station 403, power canal line; iron post stamped "2143 PHNX"	2,142.956
Livingstone, 200 feet southeast of station 230, power canal, 250 feet west of Globe Road; iron post stamped "2172 PHNX"	2,172.024
Livingstone, 3 miles east of, 15 miles east of Roosevelt, at Lee ranch, 2 feet east of corral 75 feet south of house; iron post stamped "2169 PHNX"	2,169.121

	Feet.
Livingstone, 5 miles east of, 17 miles east of Roosevelt, west entrance to box canyon, 300 yards east of junction of Pinal Creek and Salt River, 100 feet south of where trail leaves Salt River on the way to Shute's springs, in ledge; bronze tablet stamped "2198 PHNX"	2,198.077

Line from Livingstone along Globe and Payson Road to Horrell ranch near Globe.

Livingstone, on Livingstone Mesa, 200 feet southeast of station 230, power canal, 250 feet west of Globe Road; iron post stamped "2172 PHNX"	2,172.024
Livingstone, 3 miles southeast of, on mesa, 20 feet north of Globe Road, 300 yards north of Round Mountain; iron post stamped "2483 PHNX"	2,482.977
Livingstone, 6.75 miles southeast of, on ridge, 20 feet south of Globe Road; 0.75 mile east of Danforth Hill; iron post stamped "3235 PHNX"	3,234.964
Livingstone, 9.75 miles southeast of, 20 feet north of Globe Road, opposite Smith ranch, near Summit; iron post stamped "3980 PHNX"	3,979.986
Livingstone, 12 miles southeast of, 20 feet west of Globe Road, half way between Summit and Wheatfields (Devore ranch); iron post stamped "3275 PHNX"	3,274.969
Wheatfields, 14 miles southeast of Livingstone, 5 feet from fence, north side of Globe Road at Devore ranch; 100 feet west of house; iron post stamped "2855 PHNX"	2,855.043
Wheatfields, 3 miles south of, at Hicks ranch, 17 miles southeast of Livingstone, in front of circular corral on south side of road; iron post	2,990.032

Anita, Flagstaff, Grand View, and Williams 30′ Quadrangles, in Chino and San Francisco Mountain 1° Quadrangles.

COCONINO AND YAVAPAI COUNTIES.

The elevations in the following list are in agreement with the unadjusted elevations of bench marks between Ashfork and Flagstaff, established by the Coast and Geodetic Survey in 1909. Additional elevations in the Williams quadrangle are given under precise leveling.

The leveling in the Flagstaff quadrangle and part of the work in the other three quadrangles was done in 1907 by T. A. Green. Some leveling in the Anita and Grand View quadrangle was done in 1902 and 1903 by J. T. Stewart, and in these quadrangles and Williams quadrangle in 1904 by M. S. Bright.

WILLIAMS QUADRANGLE.

Williams east along Atchison, Topeka & Santa Fe Ry. to Chalender.

	Feet.
Williams, 8 feet west of northwest corner of Grand Canyon Hotel; iron post stamped "6770 CANYON"	[1] 6,765.909

[1] Elevation by Coast and Geodetic Survey unadjusted precise level line, 1909.

	Feet.
Williams, 0.57 mile east of, at junction with Grand Canyon Ry.; top of rail	6,752.1
Williams, 3.19 miles east of, 80 feet north of track, 65 feet northwest of milepost 375, 12 feet south of fence, in rock; aluminum tablet stamped "6952-1907"	[1] 6,950.045
Railroad bridge No. 375-A, south side on southeast corner of east stone abutment	[1] 6,928.312
Davern siding, in front of sign block; top of rail	6,978.5
Williams, 6.35 miles east of, 786 feet east of milepost 372, at east end of Davern siding, in southeast corner of east stone abutment on south side of railroad bridge 372-B; aluminum tablet stamped "6953-1907"	[1] 6,951.580

Williams north along Grand Canyon Ry. to Prado siding.

Williams, 2.25 miles north of, 1,700 feet south of milepost 2, at south end of cut, 40 feet west of track, in volcanic rock; aluminum tablet stamped "6753 CANYON"	6,748.419
Williams, 7.25 miles north of, 40 feet south of road crossing, 15 feet east of track, 10 feet west of wagon road; iron post stamped "6565 CANYON"	6,560.613
Williams, 10.5 miles north of, midway between mileposts 10 and 11, 20 feet north of road crossing, 3 feet south of telephone pole; iron post stamped "6463 CANYON"	6,458.961
Prado, 7.25 miles south of, 250 feet south of road crossing, 40 feet west of track, 6 feet south of milepost 13; iron post stamped "6252 CANYON"	6,247.784
Prado, 4.5 miles south of, 0.25 mile south of milepost 16, 240 feet south of bridge 14, 50 feet west of track, 30 feet east of wagon road; iron post stamped "6074 CANYON"	6,069.565

FLAGSTAFF 30' QUADRANGLE.

Chalender east along Atchison, Topeka & Santa Fe Ry. to milepost 340.

Chalender, 125 feet west of station, 50 feet west of tracks, 30 feet south of south end of snow fence, in rock; aluminum tablet stamped "6869-1907"	[1] 6,866.790
Chalender, in front of station; top of rail	6,868.8
T. 22 N., R. 4 E., sec. 32, 1.98 miles east of Chalender, 473 feet west of milepost 366, on north side of railroad bridge 367-A over wagon road, in northeast corner of stone abutment; aluminum tablet stamped "6852-1907"	[1] 6,849.711
Chalender, 4.05 miles east of, north side of track at milepost 364, in top of west rack for emergency rail; nail	6,989.8
Maine (Rhodes post office), 90 feet north of station, 40 feet north of track, south side of pine tree, in rock; sec. 26, T. 22 N., R. 4 E.; aluminum tablet "7086-1907"	[1] 7,084.406
Maine, in front of station; top of rail	7,083
Maine, 1.99 miles east of, 350 feet east of half-mile post and section post 48 and 49, on north side of track, in east end of stone culvert 361-A; aluminum tablet stamped "7178-1907"	[1] 7,175.713
Arey siding, in front of signboard; top of rail	7,194

[1] Elevation by Coast and Geodetic Survey unadjusted precise level line, 1909.

	Feet.
Maine, 4.48 miles east of, 0.57 mile east of Arey siding, 45 feet directly north of milepost 358, 5 feet south of fence, in rock, aluminum tablet stamped "7193–1907"	[1] 7,191.370
Bellemont, in front of station; top of rail	7,131.4
Bellemont, 0.31 mile east of station, 125 feet southwest of milepost 356, on east side of railroad bridge 357–A, in west end of east stone abutment; aluminum tablet stamped "7131–1907"	[1] 7,129.058
Bellemont, 3.32 miles east of, 100 feet southeast of milepost 353, 30 feet east of telephone pole, in rock; aluminum tablet stamped "7186–1907"	[1] 7,184
Riordan, in front of station; top of rail	7,311.1
Arizona Divide, in front of signboard; top of rail	7,312.5
Riordan, 0.69 mile east of, 466 feet east of road crossing, 403 feet west of milepost 350, in south end of east stone abutment of railroad bridge 351–A; aluminum tablet stamped "7273–1907"	[1] 7,271.488
Agassiz siding, in front of signboard; top of rail	7,107.3
Riordan, 3.61 miles east of, 0.3 mile east of Agassiz siding, 175 feet east of east end of switch, north side of track, 20 feet west of telegraph pole, in rock; aluminum tablet stamped "7091–1907"	[1] 7,088.616
Flagstaff, 300 feet north of railroad, 20 feet south of front entrance to Citizens' Bank, in north end of south stone window sill; aluminum tablet stamped "6907–1907"	[1] 6,904.862
Flagstaff, in front of station; top of rail	6,895.4
Flagstaff, 2.1 miles east of, 60 feet west of milepost 342, on north end of east stone abutment of railroad bridge 343–A; cross	[1] 6,838.42
Flagstaff, 3.11 miles east of, 90 feet southwest of milepost 341, 60 feet south of track, in rock; aluminum tablet stamped "6843–1907"	[1] 6,840.421
Bellemont north along wagon road to Slate Mountain, thence west to sec. 6, T. 24 N., R. 5 E.	
Bellemont, 3.03 miles north of, 80 feet east of road, on top of hill in center of triangle formed by three pine trees, in rock; aluminum tablet stamped "7347–1907"	7,344.870
T. 22 N., R. 5 E., sec. 2, 0.45 mile north of Kipson ranch, 90 feet west of road, in pile of rocks; aluminum tablet stamped "7593–1907"	7,590.449
T. 23 N., R. 5 E., sec. 26, 3.01 miles north of Kipson ranch, 125 feet northeast of northeast corner of old ranch house, 50 feet south of wagon road, in rock; aluminum tablet stamped "7664–1907"	7,661.637
T. 23 N., R. 5 E., sec. 12, 5.9 miles north of Kipson ranch, 300 feet northeast of northeast corner of old cabin, 85 feet northeast of triangular group of pine trees, in rock; aluminum tablet stamped "7910–1907"	7,907.856
T. 24 N., R. 5 E., sec. 25, 1.05 miles northwest of Hibbon ranch, 45 feet south of road, in ledge of rock; aluminum tablet stamped "7843–1907"	7,841.017
T. 24 N., R. 5 E., secs. 14 and 15, 3.77 miles northwest of Hibbon ranch, 45 feet west of road, in east end of ledge of rock; aluminum tablet stamped "7387–1907"	7,385.018
T. 24 N., R. 5 E., sec. 5, 6.96 miles northwest of Hibbon ranch, on south side of road, on east side of shallow draw, in rock; aluminum tablet stamped "7001–1907"	6,998.613

[1] Elevation by Coast and Geodetic Survey unadjusted precise level line, 1909.

Milepost 340 on Atchison, Topeka & Santa Fe Ry. near Greenlaw's mill north along wagon road to road fork north of Smith's tanks, thence west to point 6 miles north of Kipsons River.

	Feet.
Greenlaw's mill, 30 feet north of northwest corner of sawmill, on west side of pine tree 4 feet in diameter, 125 feet west of wagon road, in rock; aluminum tablet stamped "6850–1907"	6,847.495
T. 22 N., R. 8 E., sec. 21, 3.2 miles north of Greenlaw's mill, 70 feet east of road, north side of pine, in rock; aluminum tablet stamped "6792–1907"	6,790.043
T. 22 N., R. 8 E., sec. 9, 5.84 miles north of Greenlaw's mill, 20 feet east of road, 900 feet west of old cabin, in rock; aluminum tablet stamped "6723–1907"	6,721.054
T. 23 N., R. 8 E., sec. 29, 8.93 miles north of Greenlaw's mill, 80 feet east of road, just east of where road makes sharp bend to go up hill, in ledge of rock; aluminum tablet stamped "7125–1907"	7,123.066
T. 23 N., R. 8 E., sec. 17, 825 feet north of Jack Smith's tank, west side of road, in large outcrop of rock; aluminum tablet stamped "7196–1907"	7,193.500
T. 24 N., R. 8 E., sec. 6, 2.62 miles northwest of Jack Smith's tank, 25 feet south of road, in rock south of cedar bush; aluminum tablet stamped "7020–1907"	7,018.000
T. 24 N., R. 7 E., sec. 27, 5.71 miles northwest of Jack Smith's tank, 60 feet south of road, in rock beside rock monument; aluminum tablet stamped "6891–1907"	6,888.650
T. 24 N., R. 7 E., sec. 16, 7.78 miles northwest of Jack Smith's tank, 35 feet south of road, near cedar bush, in rock in pile of rocks; aluminum tablet stamped "7067–1907"	7,064.413
T. 24 N., R. 7 E., sec. 9, 9.33 miles northwest of Jack Smith's tank, at main crossroads, north side of road just east of four corners, in rock; aluminum tablet stamped "7067–1907"	7,065.204
T. 24 N., R. 7 E., sec. 19, 3.09 miles southwest of crossroads, at main forks of road, 212 feet north of center of forks, in rock; aluminum tablet stamped "7432–1907"	7,429.291
T. 24 N., R. 6 E., sec. 36, 245 feet west of milepost 20, on south side of draw, 8 feet east of pine, in rock; aluminum tablet stamped "7740–1907"	7,737.639
T. 23 N., R. 6 E., sec. 4, 3.15 miles west of milepost 20, 20 feet west of cattle trail, in outcrop of rock; aluminum tablet stamped "7874–1907"	7,871.282
T. 23 N., R. 5 E., 5.9 miles north of Kipson ranch, 300 feet northeast of northeast corner of old cabin; aluminum tablet stamped "7910–1907"	7,907.856

Flagstaff south along Old Verde Road to pump house, thence east to St. Marys Lake, thence northwest to Flagstaff.

Flagstaff, in east window sill at Citizen's Bank; aluminum tablet stamped "6907–1907"	6,904.862
Flagstaff, 3.09 miles south of, 70 feet east of road, in small draw, in rock; aluminum tablet stamped "6912–1907"	6,909.637
Flagstaff, 5.75 miles south of, 205 feet south of old railroad crossing, east side of wagon road, 75 feet northeast of fence corner; iron post stamped "6913–1907"	6,910.987

	Feet.
Pump house, at crossroads, on top of hill, east side of road, 20 feet north of four corners, in rock; aluminum tablet stamped "6751–1907"	6,748.445
Pump house, 3.05 miles east of, 45 feet north of road, 500 feet west of divide, in ledge of rock; aluminum tablet stamped "6929–1907"	6,926.768
Pump house, 6.06 miles east of, 50 feet south of wagon road, 5 feet south of old railroad grade, at sharp bend, in ledge of rock; aluminum tablet stamped "6814–1907"	6,811.505
St. Marys Lake, at northwest corner, 30 feet north of wagon road, 30 feet northwest of dam, in rock; aluminum tablet stamped "6809–1907"	6,807.110
St. Marys Lake, 3.06 miles northwest of, 10 feet north of road; iron post stamped "6883–1907"	6,881.022
St. Marys Lake, 5.82 miles northwest of, 20 feet south of road; iron post stamped "6908–1907"	6,906.016

Pump house west along wagon road to Oak Creek Canyon.

Flagstaff, 8.73 miles southwest of, on north side of road, 150 feet east of old house and barn, in rock; aluminum tablet stamped "6875–1907"	6,873.304
Flagstaff, 11.48 miles southwest of, 50 feet west of road, on north side of small draw, in rock; aluminum tablet stamped "6590–1907"	6,588.057
Oak Creek Canyon, on east rim where wagon road starts down into canyon, west side of road, in rock; aluminum tablet stamped "6413–1907"	6,410.695

GRAND VIEW QUADRANGLE.

Northwest corner of T. 24 N., R. 5 E., northwest to Ebert ranch.

Hibbon ranch, 8.99 miles northwest of, in open prairie, on east side of cattle trail, in root of cedar tree; nail marked "U.S.B.M. 6807"	6,804.96
Hibbon ranch, 10.18 miles northwest of, on west side of well-traveled wagon road running north and south, on rock; point marked "U.S.B.M. 6782"	6,779.55
T. 25 N., R. 4 E., 10.7 miles northwest of Hibbon ranch, 90 feet east of road, 30 feet west of cedar tree, in rock; aluminum tablet stamped "6770–1907"	6,768.076
Hibbon ranch, 12.19 miles northwest of, on west side of road, point on rock marked "U.S.B.M.–6713"	6,711.13
T. 25 N., R. 4 E., 12.99 miles northwest of Hibbon ranch, on west side of road, south of divide, in flint rock; aluminum tablet stamped "6710–1907"	6,708.058
Hibbon ranch, 14.32 miles northwest of, at junction with dim road running southeast, on west side of road; point on rock; stake marked "U.S.B.M. 6545"	6,542.63
Hibbon ranch, 15.20 miles northwest of, on north side of road; top of small rock; large loose rock marked "6540 B.M."	6,537.36
Hibbon ranch, 15.51 miles northwest of, on north side of road, at sharp bend where road runs into woods; point on rock marked "U.S.B.M. 6519"	6,517.29

Grand View point south to Grand View, thence northeast to New Hance trail and down trail 1.2 miles.

	Feet.
Grand View Point, 150 feet north of cabin, west side of head of trail, in solid limestone ledge under rim; aluminum tablet stamped "7406 CANYON"	7,401.591
Grand View, 50 feet west of Grand View Hotel; iron post stamped "7496 CANYON"	7,491.283
Hance ranch, sec. 15, T. 30 N., R. 4 E., 150 feet southeast of old ranch house; iron post stamped "7186 CANYON"	7,181.532
Head of Red Canyon or New Hance trail, 20 feet west of limestone ledge, at rim of canyon; bronze tablet stamped "6982 CANYON"	6,977.551
Head of trail, 0.4 mile north of, on east side of trail, in red ledge at foot of cliff; bronze tablet stamped "6482 CANYON"	6,477.676
Head of trail, 0.8 mile north of, 20 feet east and 20 feet south of trail, in large sandstone bowlder; bronze tablet stamped "5882 CANYON"	5,877.199
Head of trail, 1.2 miles north of, 15 feet east of trail, in very large sandstone rock lying on sloping side of ravine; aluminum tablet stamped "5337 CANYON"	5,332.504

Hance ranch east to point 1 mile west of Deer tank.

Hance ranch, sec. 15, T. 30 N., R. 4 E., 150 feet southeast of house; iron post stamped "7186 CANYON"	7,181.532
Hull's Tank, 2.25 miles east of, north side of canyon, 20 feet north of road, in limestone ledge; aluminum tablet stamped "6805 CANYON"	6,799.817
Hull's Tank, 5.25 miles east of, on slight north and south ridge, 5 feet north of road, in limestone outcrop flush with ground; aluminum tablet stamped "6693 CANYON"	6,687.601
Deer Tank, 1 mile west of, in loop of road west side of small draw, in limestone outcrop; aluminum tablet stamped "6688 CANYON"	6,683.459

ANITA QUADRANGLE.

Ebert ranch west along trails to milepost 19 on Grand Canyon Ry.

Ebert ranch, inside of inclosure around water tank, on south side, in rock; aluminum tablet stamped "6470–1907"	6,467.373
Ebert ranch, 1.07 miles west of; center of road at forks	6,377.51
Ebert ranch, 1.17 miles west of, 500 feet west of forks, on north side of road; point on rock, marked "U.S.B.M. 6381"	6,379.06
Ebert ranch, 1.80 miles west of, 100 feet south of southeast corner of old cabin formerly occupied by William Pitts; point on rock; house marked "6413"	6,410.28
Ebert ranch, 2.83 miles west of, on north side of mesa; point on rock, marked "U.S.B.M. 6309"	6,306.41
Ebert ranch, 3.41 miles west of, on north side of trail, 20 feet west of cedar tree, on north side of small draw, in red sandstone outcrop; aluminum tablet stamped "6304–1907"	6,301.427
Ebert ranch, 4.52 miles west of, on east side of cattle trail, in open draw; point on rock buried in ground, marked "U.S.B.M. 6217"	6,214.81
Ebert ranch, 5.80 miles west of, on north side of trail, 35 feet west of clump of cedar trees, in rock buried in ground; aluminum tablet stamped "6163–1907"	6,160.938

	Feet.
Ebert ranch, 6.64 miles west of, on west side of trail; point on rock, marked "U.S.B.M. 6182"	6,179.59
Ebert ranch, 7.70 miles west of, on north nose of Beals Hill, on south side of trail; point on rock, marked "U.S.B.M. 6178"	6,175.28
Ebert ranch, 8.77 miles west of, in open prairie, 20 feet north of a cedar tree; point on rock, marked "U.S.B.M. 6163"	6,160.23
Ebert ranch, 9.47 miles west of, on east side of cattle trail, running directly southwest to Howards Lake, in rock buried in ground; aluminum tablet stamped "6165–1907"	6,162.344
Ebert ranch, 10.56 miles west of, on north side of trail, 30 feet northwest of cedar tree; point on rock, marked "U.S.B.M. 6154"	6,151.92
Ebert ranch, 10.87 miles west of, on west side of cattle trail, near top of hill leading down to draw, in rock buried in ground; aluminum tablet stamped "6161–1907"	6,158.590
Ebert ranch, 11.88 miles west of, on north side of trail, on top of hill; point on rock, marked "U.S.B.M. 6175"	6,172.38
Howards Lake, 1.08 miles east of, 40 feet south of road, in rock; aluminum tablet stamped "6166–1907"	6,163.576
Howards Lake, on north side of fence around lake, on rock point; fence post marked "U.S.B.M. 6144"	6,141.65
Howards Lake, on west side of lake, 30 feet west of Grand Canyon wagon road, 600 feet north of house occupied by ranch overseer, 400 feet north of road forks, in rock; aluminum tablet stamped "6175–1907"	6,172.183
Howards Lake, 0.92 mile west of, 100 feet north of road forks, on north side of road running northwest; point on rock, marked "U.S.B.M. 6117"	6,114.57
Howards siding, 0.75 mile north of, 1.5 miles south of Prado, on east side of railroad, 80 feet east of milepost 19; iron post stamped "6068 CANYON"	6,063.492

Grand View northwest 1.8 miles.

Grand View Hotel, 1.8 miles northwest of, 20 feet south of road at Berry's pasture gate; iron post stamped "7475 CANYON"	7,470.619

Apex east to Grand View.

Coconino, 1.5 miles southeast of, 100 feet north of track at mileboard 56; aluminum tablet stamped "6401 CANYON"	6,395.98
Apex, 0.5 mile north of, 50 feet southeast of crossing of track by wagon road; iron post stamped "6564 CANYON"	6,559.251
Rain Tank, 0.5 mile east of, 150 feet east of road fork on top of limestone ledge; aluminum tablet stamped "6580 CANYON"	6,575.090
Rain Tank, 3.7 miles northeast of, 50 feet southeast of road near big pine tree; iron post stamped "6702 CANYON"	6,697.026
Rain Tank, 7 miles east of, 4.5 miles west of Grand View Hotel, south side of road; iron post stamped "6881 CANYON"	6,875.930
Grand View Hotel, 2.2 miles southwest of, 20 feet east of road at forks; iron post stamped "7300 CANYON"	7,295.040

Apex south along Grand Canyon Ry. to milepost 19.

Apex, 0.25 mile north of, 45 feet southeast of wagon and railroad crossing; iron post stamped "6564 CANYON"	6,559.251

	Feet.
Apex, 3 miles south of, 320 feet north of milepost 49, 40 feet west of track, south end of cut, 4 feet south of telephone pole, in limestone outcrop; aluminum tablet stamped "6397 CANYON"	6,392.004
Anita, 0.25 mile north of water tank, 200 feet west of water car siding, east point of ridge, in limestone outcrop; aluminum tablet stamped "5982 CANYON"	5,977.242
Anita, 2 miles south of, 40 feet west of track, 30 feet east of wagon road, 2 feet south of milepost 43; iron post stamped "5850 CANYON"	5,845.537
Anita, 5 miles south of, 250 feet south of milepost 40, 75 feet east of track, 25 feet east of old wagon road, north side of low ridge, in limestone outcrop; aluminum tablet stamped "5816 CANYON"	5,811.845
Willaha, 0.75 mile south of, 40 feet west of track, 4 feet southwest of milepost 37; iron post stamped "5806 CANYON"	5,801.510
Willaha, 3.75 miles south of, 40 feet west of track, 3 feet south of milepost 34; iron post stamped "5798 CANYON"	5,793.421
Valle, 1.5 miles northwest of, midway between milepost 30 and 31, top of ridge, 50 feet east of track, west edge of wagon road; iron post stamped "5871 CANYON"	5,866.633
Valle, 1 mile south of, 40 feet west of track, 4 feet west of milepost 28; iron post stamped "5908 CANYON"	5,903.443
Valle, 4 miles south of, 50 feet west of track, 2 feet west of milepost 25; iron post stamped "5962 CANYON"	5,957.625
Prado, 1.5 miles north of, 200 feet south of milepost 21, 400 feet west of track, 20 feet east of wagon road, 12 feet north of telephone pole; iron post stamped "6017 CANYON"	6,012.547
Prado, 1.5 miles south of, 60 feet east of milepost 19, 40 feet east of track, 10 feet east of wagon road; iron post stamped "6068 CANYON"	6,063.492

Bright Angel, Shinumo, and Vishnu Quadrangles.

COCONINO COUNTY.

The elevations in the following list are based on an aluminum tablet in rim rock north of Bright Angel Hotel at Grand Canyon, stamped "6866 CANYON." The elevation of this bench mark is accepted as 6,861.409 feet, as determined by primary levels along the Grand Canyon Railway, corrected to the unadjusted elevations of bench marks at Williams determined by precise leveling of Coast and Geodetic Survey in 1909.

The leveling was done by John T. Stewart in 1902 and 1903, and by M. S. Bright in 1904.

BRIGHT ANGEL QUADRANGLE.

Grand Canyon southeast along stage road via Grand View Hotel to Zuni Point (Bissell Point).

	Feet.
Grand Canyon, station, point on rim of canyon, 100 feet north of Bright Angel Hotel, in rim ledge; aluminum tablet stamped "6866 CANYON"	6,861.409

	Feet.
Grand Canyon, 3.4 miles southeast of, near northeast corner of sec. 1, T. 30 N., R. 2 E., 25 feet south of stage road; iron post stamped "6837 CANYON"	6,832.495
Grand Canyon, 6 miles southeast of, sec. 8, T. 30 N., R. 3 E., south side of road in Long Jim Draw; iron post stamped "6811 CANYON"	6,806.467
Grand Canyon, 9.1 miles southeast of, near quarter corner west side of sec. 11, T, 30 N., R. 3 E., 25 feet west of road on bank near where road goes down into Long Jim Draw; iron post stamped "7195 CANYON"	7,190.587

Grand Canyon north via Bright Angel trail down to Colorado River (single-spur line).

Bright Angel Hotel, 0.4 mile north of, west side of trail, top of large rock detached from ledge; aluminum tablet stamped "6327 CANYON"	6,322.227
Bright Angel Hotel, 0.7 mile north of, 15 feet north of trail, large sandstone rock detached from ledge; aluminum tablet stamped "5866 CANYON"	5,861.459
Bright Angel Hotel, 1.2 miles north of, west side of trail near bed of ravine, reddish sandstone ledge 2 feet higher than trail; aluminum tablet stamped "5361 CANYON"	5,356.105
Bright Angel Hotel, 1.5 miles north of, 25 feet north of trail on rim of red wall, 50 feet northwest of ravine, brown rock detached from ledge; aluminum tablet stamped "4850 CANYON"	4,845.263
Bright Angel Hotel, 1.9 miles north of, 20 feet east of trail below red wall, small limestone rock; aluminum tablet stamped "4348 CANYON"	4,343.723
Bright Angel Hotel, 2.8 miles north of, west side of trail, 100 feet west of ravine, limestone rock 3 feet high; bronze tablet stamped "3876 CANYON"	3,871.685
Bright Angel Hotel, 4.2 miles north of, rim of Granite Gorge at end of Plateau trail, 75 feet south of edge of rim, in quartzite ledge; aluminum tablet stamped "3708 CANYON" (on spur)	3,703.524
Bright Angel Hotel, 3.9 miles north of, east edge of trail at top of granite near Salt Creek, sandstone rock; bronze tablet stamped "3472 CANYON"	3,467.750
Bright Angel Hotel, 4.5 miles north of, east side of trail in Pipe Creek, limestone rock opposite mouth of Salt Creek; bronze tablet stamped "2781 CANYON"	2,776.525
Bright Angel Hotel, 5.4 miles north of; 100 feet northeast of mouth of Pipe Creek, high-water mark on south side of Colorado River, granite ledge; bronze tablet stamped "2436 CANYON"	2,431.316
Mouth of Pipe Creek, surface of water of Colorado River, June 6, 1902	2,412.

Grand Canyon west to Rowes Point, thence south to Rowes Well, thence west to Bass Camp.

Sentinel (Maricopa) Point, sec. 14, T. 31 N., R. 2 E., top of upper stratum of solid rock near point, on rim; aluminum tablet stamped "7050 CANYON"	7,045.187

	Feet.
Rowes Point (Hopi Point), Rowe triangulation station, sec. 14, T. 31 N., R. 2 E., 100 feet north of road to Rowes Point, 2 feet under surface at foot of 10-inch stump 10 feet high, bronze tablet stamped "7071 CANYON"	7,066.311
Rowes Well, near quarter corner on south side of sec. 28, T. 31 N., R. 2 E., 150 feet north of largest cabin, 40 feet north of Supai Road, 30 feet west of Rowe Point Road, flat sheet limestone; aluminum tablet stamped "6681 CANYON"	6,676.524
T. 31 N., R. 2 E., SW. ¼ sec. 30, 2.7 miles southwest of Rowes Well, east edge of ridge 200 feet west of old horse ranch, north side of road, limestone ledge; aluminum tablet stamped "6462 CANYON"	6,457.565

Point 14.7 miles southeast of Bass Camp east to Bass siding.

T. 30 N., R. 1 E., NW. ¼ sec. 12, 3.5 miles west of Bass Siding, in canyon 50 feet north of road forks; aluminum tablet stamped "6211 CANYON"	6,206.368
South side of road, in root of 15-inch pine; nail	6,240.46
Bass siding, 100 feet north of road, SE. ¼ sec. 5, T. 30 N., R. 2 E., 250 feet northeast of camp, ledge in side of hill; aluminum tablet stamped "6417 CANYON"	6,412.107

VISHNU QUADRANGLE.

Head of Red Canyon or New Hance trail to Bissel Point (Zuni Point).

Morans Point, northern point of upper strata of limestone at rim; aluminum tablet stamped "7157 CANYON"	7,151.974
Bissell Point (Zuni Point), top of strata of limestone at rim; bronze triangulation tablet stamped "7284 CANYON"	7,279.387

Point 2.1 miles north of head of trail north to Colorado River.

Head of trail, 2.1 miles north of, north side of trail at top of red wall, limestone rock 8 feet square; aluminum tablet stamped "4955 CANYON"	4,950.726
Head of trail, 2.6 miles north of, 20 feet east of, in white limestone rock 3 feet higher than trail; aluminum tablet stamped "4292 CANYON"	4,287.609
Head of trail, 3.2 miles north of, east side of trail, east of junction of two ravines, sandstone rock in side of hill; aluminum tablet stamped "3665 CANYON"	3,660.115
Head of trail, 4.1 miles north of, 1 mile south of Colorado River, large stripped sandstone rock on west side of ravine and east side of trail; aluminum tablet stamped "2999 CANYON"	2,994.224
Head of trail, 5.1 miles north of, 300 feet northeast of Hance River Camp, 21 feet above high-water mark on south bank of Colorado River, sloping sandstone; aluminum tablet stamped "2614 CANYON"	2,609.465
Colorado River, at head of Granite Rapid; high-water mark	2,590
Colorado River, surface of water, June 24, 1902	2,571

Point 1 mile west of Deer Tank northeast to Comanche Point.

	Feet.
Deer Tank, 2.8 miles northwest of, 100 feet south of point where road crosses to west side of canyon, 40 feet west of road west side of canyon, in top of limestone ledge about 12 feet above road; aluminum tablet stamped "6817 CANYON"	6,812.246
Deer Tank, 5.5 miles north of, north point of ridge, 100 feet east of point where road drops into canyon, 20 feet north of road, in limestone outcrop; aluminum tablet stamped "6452 CANYON"	6,447.160
Comanche Point, top of south edge of monument in lime rock; aluminum tablet stamped "7079 CANYON"	7,074.444

SHINUMO QUADRANGLE.

Point 12.6 miles southeast of Bass Camp northwest to Bass Camp.

Bass Camp, 12.6 miles southeast of, 3.6 miles west of Deserted Horse ranch, 50 feet south of road, limestone rock 12 inches high; aluminum tablet stamped "6340 CANYON"	6,334.853
T. 31 N., R. 1 E., sec. 19, 10 miles southeast of Bass Camp, 50 feet northwest of the intersection of Bass-Bass Siding and Bright Angel-Supai Roads; bronze tablet in rock stamped "6235 CANYON"	6,230.351
T. 31 N., R. 1 E., near quarter corner on west side of sec. 7, 6.7 miles southeast of Bass Camp, top of ridge in big patch of sage; iron post stamped "6372 CANYON"	6,367.538
T. 22 N., R. 1 W., NE. ¼ sec. 35, unsurveyed, 4.8 miles southeast of Bass Camp, north side of road on canyon rim; bronze tablet stamped "6519 CANYON"	6,514.746
Bass Camp, 2.6 miles southeast of, 25 feet west of gate in pasture fence; iron post stamped "6568 CANYON"	6,563.343
Bass Camp, 1.5 miles southeast of, 200 feet south of road to Havasupai Point, Bass triangulation station; bronze tablet stamped "6780 CANYON"	6,775.165

Bass Camp north along Mystic Spring trail, across Colorado River, and north via Shinumo Camp to rim of Kaibab Plateau (single-spur line).

Bass Camp, 0.5 mile north of, west side of trail above cistern, near top of cross-bedded sandstone; aluminum tablet stamped "6146 CANYON"	6,141.311
Bass Camp, 1 mile north of, east side of trail, in sandstone rock; aluminum tablet stamped "5635 CANYON"	5,630.407
Bass Camp, 2.1 miles north of, top of plateau west side of trail, at foot of sandstone ledge; aluminum tablet stamped "5376 CANYON"	5,371.412
Bass Camp, 2.7 miles north of, west side of trail, in Aubrey sandstone; aluminum tablet stamped "4857 CANYON"	4,851.777
Bass Camp 3.1 miles north of, west side of trail, in red wall; aluminum tablet stamped "4360 CANYON"	4,354.799
Bass Camp, 3.8 miles north of, north side of trail near foot of red wall; aluminum tablet stamped "3824 CANYON"	3,819.824
Bass Camp, 4.5 miles north of, west side of trail, in reddish rock near top of bank; aluminum tablet stamped "3345 CANYON"	3,339.941
Bass Camp, 5.4 miles north of, sandstone rock on west side of trail near Rock Camp; aluminum tablet stamped "2842 CANYON"	2,837.293

	Feet.
Bass Camp, 6.5 miles north of, southwest side of river, south side of trail in granite ledge at high water mark of Colorado River; aluminum tablet stamped "2230 CANYON"	2,225.490
Bass Ferry, surface of Colorado River at 4.30 p. m., March 20, 1903	2,195.8
Bass Ferry, bottom of Colorado River	2,144
Bass Ferry, north side of river, top of gorge 30 feet south of trail; aluminum tablet stamped "2272 CANYON"	2,267.182
Bass Ferry, 1 mile northwest of, top of ridge on way to Shinumo Creek, north side of trail; aluminum tablet stamped "2923 CANYON"	2,918.215
Shinumo Camp, on sandstone rock; aluminum tablet stamped "2483 CANYON"	2,477.973
Shinumo Camp, 1.1 miles above, 50 feet south of trail, 75 feet south of creek; aluminum tablet stamped "2674 CANYON"	2,669.313
Shinumo Camp, 1.6 miles above, on point of high sandstone bluff, east of trail near Blue Dick claim; aluminum tablet stamped "3156 CANYON"	3,151.358
Shinumo Camp, 3.3 miles above, north side of Moab Canyon, north side of trail; aluminum tablet stamped "3486 CANYON"	3,481.245
Shinumo Camp, 4.7 miles above, south side of sharp bend, near fall in Moab Canyon; aluminum tablet stamped "4006 CANYON"	4,001.323
Shinumo Camp, 5.6 miles above, south side and 150 feet above bottom of Moab Canyon; aluminum tablet stamped "4527 CANYON"	4,521.935
Shinumo Camp, 5.9 miles above, high point of limestone north of trail near big piñon tree; aluminum tablet stamped "5012 CANYON"	5,007.297
Shinumo Camp, 7 miles above, south of trail, where it returns to Moab Canyon, on top of red wall; aluminum tablet stamped "5181 CANYON"	5,176.222
Shinumo Camp, 8 miles above, south side of trail in dry gulch; aluminum tablet stamped "5697 CANYON"	5,692.630
Shinumo Camp, 8.4 miles above, on slide about half way between gulch and foot of cross-bedded sandstone, east side of trail, in sandstone rock; aluminum tablet stamped "6262 CANYON"	6,257
Shinumo Camp, 8.9 miles above, in saddle at head of Moab Canyon, near point where trail forks for Powell and Kaibab plateaus, yellow standstone rock; aluminum tablet stamped "6717 CANYON"	6,711.989
Shinumo Camp, 9 miles above, between saddle and rim of Kaibab plateau, north side of trail, in sandstone ledge; aluminum tablet stamped "7057 CANYON"	7,052.109
Shinumo Camp, 9.3 miles above, north rim of canyon where trail comes out on Kaibab plateau, known as swampy point, 35 feet east of rim, 50 feet south of trail, three witness trees blazed and painted, flat quartzite rock; aluminum tablet stamped "7523 CANYON"	7,517.837

Bass Camp, south along Ashfork Road, to point 9.8 miles south of Bass Camp (mean of two lines).

Bass Camp, on rim of canyon, 100 feet from house; aluminum tablet stamped "6652 CANYON"	6,646.949
Bass Camp, 3.9 miles southwest of, 25 feet east of the intersection of Bass, Ashfork, and Bright Angel-Supai Road; iron post stamped "6302 CANYON"	6,297.416

	Feet.
T. 31 N., R. 1 W., near quarter corner on south side of sec. 4, 6.7 miles south of Bass Camp, 30 feet south of quarter-section corner, east side of road, at end of rocky point; aluminum tablet stamped "6154 CANYON"	6,149.611
T. 31 N., R. 1 W., about south side of sec. 21, 9.8 miles south of Bass Camp, 15 feet west of road, near a clump of trees on ridge; iron post stamped "6012 CANYON"	6,007.090

Line from bench mark 6302 (forks) west along Supai Road to gate of Indian pasture.

Bass Camp, 6.5 miles southwest of, 25 feet north of road; iron post stamped "6144 CANYON"	6,139.203
Bass Camp, 9 miles southwest of, 25 feet northeast of gate at Indian pasture; iron post stamped "6129 CANYON"	6,124.131

Forks south of Bass Camp southeast to point 3.5 miles west of Bass siding.

T. 32 N., R. 1 W., S. ½ sec. 35, 6.7 miles southeast of Bass Camp, 25 feet west of forks of Supai and old Bass siding roads; iron post stamped "6412 CANYON"	6,407.263
T. 31 N., R. 1 W., near center of sec. 13, 9.7 miles southeast of Bass Camp, 100 feet east of road forks, limestone ledge; aluminum tablet stamped "6243 CANYON"	6,238.287
Bass Camp, 12.4 miles southeast of, 25 feet west of road, top of ridge; iron post stamped "6221 CANYON"	6,216.231
Bass Camp, 14.7 miles southeast of, 5.5 miles northwest of Bass siding, 20 feet southeast of road fork; iron post stamped "6213 CANYON"	6,208.378

Camp Mohave, Castle Dome, Ehrenberg special, Needles special, Parker, Picacho, Quartzsite, Wellton, and Yuma quadrangles and quadrangle south of Quartzsite quadrangle.

MOHAVE AND YUMA COUNTIES.

The elevations in the following list are based on a double-rodded primary level line from San Bernardino to Yuma, based upon the Coast and Geodetic Survey unadjusted precise level line of 1906 from mean sea level at San Diego. Additional elevations in the Yuma and Wellton quadrangles are given in the precise-leveling lists from Yuma east along the Southern Pacific Railroad. Elevations in the California part of these quadrangles are given in Bulletin 342.

Most of the leveling in the Yuma and Wellton quadrangles was done in 1902–3 by G. L. Gordon and C. J. Hoover. A part of the work in the Blaisdell quadrangle was done in 1903 by L. D. Ryus. The leveling in the Picacho and Ehrenberg quadrangles was done in 1903 by C. Hartman, Gordon, and Ryus, in the Quartzsite quadrangle and the quadrangle south of it in 1903 by Ryus, in the Parker quadrangle in 1902–3 by Hartman, and in the Camp Mohave quadrangle in 1902 by Morrison. The leveling in the Needles special quadrangle was done in 1902 by Morrison, Hartman, and S. E. Blout.

In 1909 the Coast and Geodetic Survey precise-level line along the Atchison, Topeka & Santa Fe Railway redetermined bench marks near Mellen and Franconia. The unadjusted Coast and Geodetic Survey values are given in the Needles special quadrangle.

YUMA QUADRANGLE.

Yuma south along county road to Mexican boundary and return.

	Feet.
Yuma, railroad bridge, in east end of second pier, aluminum tablet stamped "137 S. B."	138.100
T. 8 S., R. 23 W., southwest corner of sec. 31, iron post stamped "118 Y"	118.616
T. 9 S., R. 24 W., sec. 1, at Eta triangulation station, 6.5 miles southwest of Yuma, bronze tablet stamped "129 Y"	129.568
Somerton, T. 9 S., R. 24 W., southeast corner of sec. 33; iron post stamped "101 Y"	101.942
T. 10 S., R. 24 W., south side of sec. 14; triangulation station "Beta," bronze tablet stamped "160 Y"	160.320
T. 10 S., R. 24 W., sec. 32, triangulation station "Gamma," bronze tablet stamped "148 Y"	148.507
T. 10 S., R. 24 W., 4.5 feet south of southwest corner of sec. 32; iron post stamped "136 Y"	136.507
Monument 205, United States and Mexico boundary line, in foundation on United States side; top of bolt	90.438
Monument 204, United States and Mexico boundary line, 6 feet north of; iron post stamped "138 Y"	138.889
Monument 204, base of masonry	138.3
Monument 204, 5.1 miles east of, 1.7 miles south of township line; iron post stamped "163 Y"	163.316
T. 10 S., R. 23 W., southeast corner of sec. 36; iron post stamped "285 Y"	285.761
T. 10 S., R. 23 W., sec. 24, triangulation station; bronze tablet stamped "291 Y"	291.791
T. 9 S., R. 23 W., southeast corner of sec. 36; iron post stamped "203 Y"	203.784
T. 9 S., R. 23 W., northeast corner of sec. 1; iron post stamped "216 Y"	216.754

Yuma southeast along Southern Pacific R. R. to Blaisdell.

T. 9 S., R. 22 W., sec. 3, at milepost 740; iron post stamped "213 Y"	213.866

Milepost 740 to triangulation station Kappa and return.

T. 8 S., R. 22 W., sec. 33, triangulation station Kappa; bronze tablet stamped "216 Y"	216.733

Yuma northeast to point near Laguna.

T. 8 S., R. 23 W., sec. 28, 1.2 miles south of Yuma, triangulation station Azimuth; aluminum tablet stamped "297 Y"	297.275
T. 8 S., R. 22 W., northeast corner of sec. 17, 1.5 feet southwest of stake; iron post stamped "144 Y"	144.751

WELLTON QUADRANGLE.

Blaisdell east along Southern Pacific R. R. to Gila City.

	Feet.
Blaisdell, railroad station, southeast corner of; iron post stamped "188 Y"	188.904
Gila City, southwest corner of station; iron post stamped "189 Y" (reported destroyed)	190.347

Blaisdell south to Fortuna and west to southwest corner of T. 10 S., R. 22 W.

Blaisdell, 6 miles southwest of, west side of road, iron post stamped "403 Y"	403.621
Fortuna, northwest corner post office; iron post stamped "746 Y"	746.696
Fortuna, 6 miles west of; iron post stamped "433 Y"	434.304
Fortuna, 11 miles west of; iron post stamped "299 Y"	300.178

Fortuna southwest 8 miles (single-spur line).

Fortuna, 5 miles southwest of; iron post stamped "509 Y"	509.868
Fortuna, 8 miles southwest of; iron post stamped "432 Y"	432.723

Gila City northwest along road and trail to point near Laguna.

Gila City, 6.2 miles northwest of, southwest side of trail at summit of pass between Gila and Colorado Rivers; iron post stamped "307 Y"	307.789
Laguna, 0.5 mile south of, east side of road at point of hill; iron post stamped "152 Y"	152.436

Near Laguna north to Castle Dome Landing.

Laguna, 4.5 miles northeast of, west side of road; iron post stamped "150 Y"	150.482
Laguna, 9.3 miles northeast of, at point of low hill, west side of road; iron post stamped "173 Y"	173.290
Castle Dome Landing, Arizona side of river bank, south of foot of bluff; iron post stamped "170 Y"	170.575

PICACHO QUADRANGLE.

Castle Dome northwest to Picacho, Cal.

Castle Dome Landing, 6 miles northwest of, 15 feet west of road; iron post stamped "175 Y"	175.755

Point opposite Picacho, Cal., north along road to Trigo, Wash.

Mexican smelter, near, 500 feet east of river, 25 feet east of wagon road, at base of mountain; iron post stamped "189 Y"	190.258
East side of wagon road, at south end of canyon, and beginning of long flat, in solid rock; bronze tablet stamped "213 Y"	214.326
"Pilot Rock," 0.5 mile south of, 300 feet east of river, 15 feet east of wagon road, at base of decayed rock mountain; bronze tablet stamped "211 Y"	212.449
Adobe house, 0.5 mile south of, 500 feet east of river, east side of wagon road; iron post stamped "244 Y"	244.740

	Feet.
Mrs. Hart's ranch, 2.5 miles north of, on west side of wagon road, in mesquite brush; iron post stamped "215 Y"	215.647
Seeley ranch, 4 miles east of river, on west side of wagon road; iron post stamped "226 Y"	226.530
Mule Wash, on low mesa at north end of, 500 feet east of river, 500 feet north of triangulation station, on Arizona side; iron post stamped "252 Y"	252.132
North side of Trigo Wash, 500 feet northeast of river, in large mesquite trunk; bronze tablet stamped "258 Y"	258.501

EHRENBERG SPECIAL QUADRANGLE.

Trigo Wash north to Ehrenberg.

Ehrenberg, 5 miles south of, on sand mesa, south of triangulation station; bronze tablet stamped "286 Y"	286.513
Ehrenberg, opposite post office, 125 feet west of S. M. Wilson's store, 100 feet east of river landing; iron post stamped "274 Y"	274.828

Ehrenberg north along road to first water station south of Parker.

Ehrenberg, 3 miles north of, on north end of mesa; iron post stamped "295 Y"	296.015
La Pas, 3 miles north of, 0.3 mile west of sand hills, on east side of Ehrenberg Road; iron post stamped "286 Y"	286.722
La Pas, 7 miles north of, east side of Ehrenberg Road, top of divide, 0.5 mile west of sand hills; iron post stamped "317 Y"	317.035
La Pas, 12 miles north of, 3 miles east of Colorado River at base of projection of mountain at south end of sand flat, in rock; bronze tablet stamped "311 Y"	311.449
La Pas, 18 miles north of, west side of Ehrenberg Road, north end of long open sand flat, 0.2 mile west of sand hills; iron post stamped "319 Y"	320.268
Parker, 11 miles south of, 0.1 mile north of the first water station south of Parker, west side of Ehrenberg Road, beside mesquite tree; iron post stamped "325 Y"	326.449

Ehrenberg northeast to Halfway Well.

Ehrenberg, 8 miles northeast of, at low hill point, 15 feet south of road; iron post stamped "747 Y"	747.964
Ehrenberg, 11.1 miles northeast of, 40 feet south of Halfway Well, on road to Tysons; iron post stamped "1004 Y"	1,004.914

Ehrenberg southeast 5 miles (single-spur line).

Ehrenberg, 4.9 miles southeast of, 12 feet north of road; iron post stamped "619 Y"	619.926

QUARTZSITE AND CASTLE DOME QUADRANGLES.

Halfway Well east to Quartzite, thence south to Weaver Pass.

Quartzsite, Quartzsite Mining & Smelting Co. store, northwest corner of fence in front of store; iron post stamped "871 Y"	872.197
Quartzsite Mining & Smelter Co. store, 6.25 miles south of, 50 feet east of road, on gravel mesa; iron post stamped "1025 Y"	1,024.600

	Feet.
Quartzsite Mining & Smelter Co. store, 11.38 miles south of, 300 feet south of wash, 20 feet west of, junction of Yuma and King of Arizona mine roads; iron post stamped "1125 Y"	1,125.639
Weaver Pass summit, 20 feet west of road; iron post stamped "1304 Y"	1,305.055

PARKER QUADRANGLE.

Water station north to Parker, thence northeast to Bill Williams Fork, thence northwest to point near Liverpool Landing.

Parker, 5 miles south of, on west side of Ehrenberg Road; iron post stamped "344 Y"	345.264
Parker, 300 feet southwest of agency building; iron post stamped "352 Y"	352.834
Parker, 2.5 miles north of, 0.5 mile east of river, on wagon road running to Parker; iron post stamped "424 Y"	424.939
Empire Flat, 1 mile south of north end of, 300 feet west of trail; iron post stamped "376 Y"	376.293
Empire Flat, 2.5 miles north of, 0.75 mile south of big wash, 75 feet east of river, in ledge of rock; bronze tablet stamped "378 Y"	378.179
Bill Williams Fork, 1,000 feet north of, 500 feet east of river, in rock; bronze tablet stamped "391 Y"	391.469
Bill Williams Fork, at north end of second flat, 5.2 miles north of, 300 feet east of river, on trail; aluminum tablet stamped "406 Y"	406.376
Bill Williams Fork, 9 miles north of, at flat, 2.5 miles long and 0.1 mile east of river, near dry stream; on trail at south end of flat; bronze tablet stamped "405 Y"	405.181
Triangulation signal, 0.5 mile northeast of, 200 feet west of river, on California side, in ledge of rock; bronze tablet stamped "417 Y"	417.619
Pittsburg Landing, at sharp bend in river, 500 feet east of river, in rock on top of small hill; bronze tablet stamped "439 Y"	439.704
Liverpool Landing, about 1 mile northeast of, 1 mile east of Colorado River, 50 feet east of highwater trail, on top of mesa; bronze tablet stamped "441 Y"	441.331

NEEDLES SPECIAL QUADRANGLE.

Liverpool Landing north to Mellen.

Mellen, 15 miles south of, in sand flat 0.5 mile wide surrounded by sand hills, signal flag stands on top of sand hills 100 feet northwest; iron post stamped "428 Y"	428.213
Mellen, 5 miles south of, 15 feet northeast of Colorado River, in large ledge of rock, projecting from side of high hill; bronze tablet stamped "465 Y"	465.781
Mellen, east end of bridge over Colorado River, south abutment; bronze tablet stamped "504 Y 1902" (Coast and Geodetic Survey, 1909, unadjusted elevation, 504.211)	504.652

Mellen east along Atchison, Topeka & Santa Fe Ry. to Franconia.

Mellen, 7 miles east of, north side of track, 75 feet north of station board at Powell; iron post stamped "762 Y"	762.968
Franconia, north side of track, 30 feet south of section house; iron post stamped "1101 Y" (Coast and Geodetic Survey, 1909, unadjusted elevation, 1,100.244)	1,101.985

Mellen north along road to Spears Lake, thence west to Needles, Cal.

	Feet.
Powell Lake, 0.4 mile west of lake and 1 mile north of south end, 50 feet east of road, 200 feet south of road fork west; iron post stamped "444"	451.671
Needles, 4.5 miles east of, 0.25 mile north of Rosenburg ranch, at windmill, 0.25 foot northwest of signboard on old tie in open flat, about 1.75 miles south of Mesa; iron post stamped "453"	460.552

Needles, Cal., north along county road in Arizona to Fort Mohave.

Needles, 1 mile east of, on east side of Colorado River, 17 feet north from fence of W. J. Sweeney's house, 116 feet east of front of house; iron post stamped "463 Y 1903"	463.697
Needles, 6 miles north of, on east side of road leading to Fort Mohave; iron post stamped "467 Y"	467.857
Needles, 11 miles north of, on west side of road leading to Fort Mohave; iron post stamped "479 Y"	479.932

CAMP MOHAVE QUADRANGLE.

At Fort Mohave.

Fort Mohave, in grounds of Indian training school, 5 feet east of flagstaff on drill ground; iron post stamped "540 Y"	540.735

Camp Mohave Quadrangle.

MOHAVE COUNTY.

The elevations in the following list are based on an iron post stamped "Y 540," set 5 feet east of the flagstaff on the drill ground at the Fort Mohave Indian Training School. Its elevation is 540.735 feet.

The leveling from Fort Mohave to Bulls Head dam site was done by C. R. Oldberg and afterwards checked by Goyne Drummond, both of the Reclamation Service.

The leveling from Bulls Head dam site to the head of Cottonwood Valley and return was done by Goyne Drummond. The circuit was closed at Bulls Head.

CAMP MOHAVE QUADRANGLE.

Fort Mohave north to a point 23 miles from Bulls Head dam site.

	Feet.
Bulls Head Road, 1 mile south of Hardyville, in cairn of rocks on east of road; iron post stamped "Y 538"	538.5
Bulls Head Road, at junction of sheep trail and Kingman Road, 50 feet from ruins of adobe house; iron post stamped "Y 522"	522.3
Bulls Head dam site, at Arizona bank of gaging station, in wall rock; bronze tablet stamped "Y 531"	531.3
Bulls Head Dam site, at upper dam site, on Arizona bank, in wall rock; copper tablet marked "Y 514"	515.2
Bulls Head, 2.5 miles north of; 60 feet west of Pyramid Rock, in rock ledge; bronze tablet stamped "Y 555"	556.1

	Feet.
Bulls Head, 6 miles north of, 2 feet west of trail, on rock 2 by 2 feet; bronze tablet marked "Y 547"	548.1
Bulls Head, 9 miles north of, 10 feet east of trail, in rock by cairn of stones; bronze tablet marked "Y 556"	557.1
Bulls Head, 13.5 miles north of, 400 feet east of Colorado River, in rock 2 by 2 feet, on gravel bank; bronze tablet stamped "Y 576"	577.5
Bulls Head, 16.6 miles north of, 1 mile east of house on island, in black rock; bronze tablet stamped "Y 584"	584.9
Bulls Head, 23.3 miles north of, 5 miles northeast of Quartette stamp mill, in rocky point; bronze tablet stamped "Y 561"	561.9

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

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RESULTS OF SPIRIT LEVELING IN NEW MEXICO

1902 TO 1909, INCLUSIVE

R. B. MARSHALL, CHIEF GEOGRAPHER

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GEOLOGICAL SURVEY BENCH MARKS

A, Tablet used in cooperating States. The State name is inserted at *G*.
B and *D*, Copper temporary bench mark, consisting of a nail and copper washer.
A, *C*, and *E*, Tablets for stone or concrete structures.
F, Iron post used where there is no rock.

RESULTS OF SPIRIT LEVELING IN NEW MEXICO, 1902 TO 1909, INCLUSIVE.

R. B. MARSHALL, Chief Geographer.

INTRODUCTION.

Scope of the work.—All results of spirit leveling in New Mexico by the United States Geological Survey are included in this report, arranged by quadrangles. All elevations are based on preliminary heights of bench marks along the precise-level line of the Coast and Geodetic Survey from San Diego, Cal., via Mellen and Flagstaff, Ariz., to Albuquerque, N. Mex., and on the precise line of the United States Geological Survey from the Arizona-New Mexico boundary line via Rincon and Albuquerque to Cuba, N. Mex.

Personnel.—The field work from 1902 to 1906, inclusive, was done under E. M. Douglas, geographer, and the later work under E. C. Barnard, geographer, under the general direction of R. B. Marshall, chief geographer. The names of the various levelmen are given in the introduction to each list. The office work of computation, adjustment, and preparation of lists was done mainly by S. S. Gannett, geographer, and D. H. Baldwin, topographer, and since 1907 under the general direction of E. M. Douglas, geographer.

Classification.—The elevations are classified as precise or primary according to the methods employed in their determination. For precise-level lines instruments and rods of the highest grade are used; each line is run both forward and backward, and every precaution is taken to guard against error. The allowable divergence between the forward and the backward lines in feet is represented by the formula $0.017\sqrt{D}$, in which D is the distance in miles between bench marks. For primary lines standard Y levels are used; lines are run in circuits or are closed on precise lines, with an allowable closing error in feet represented by $0.05\sqrt{D}$, in which D is the length of the circuit in miles, sufficient care being given to the work to maintain this standard. For levels of both classes careful office adjustments are made, the small outstanding errors being distributed over the lines.

Bench marks.—The standard bench marks are of two forms. The first form is a circular bronze or aluminum tablet (*C* and *E*, Pl. I), 3½ inches in diameter and one-quarter inch thick, having a 3-inch stem, which is cemented in a drill hole in solid rock in the wall of some public building, a bridge abutment, or other substantial masonry structure. The second form (*F*, Pl. I), used where masonry or rock is not available, consists of a hollow wrought-iron post 3½ inches in outer diameter and 4 feet in length. The bottom is spread out to a width of 10 inches in order to give a firm bearing on the earth. A bronze cap is riveted over the top of the post, which is set about 3 feet in the ground. A third style of bench mark with abbreviated lettering (*B* and *D*, Pl. I) is used for unimportant points. This consists of a special copper nail 1½ inches in length driven through a copper washer seven-eighths inch in diameter. The tablets, as well as the caps on the iron posts, are appropriately lettered, and cooperation by States is indicated by the addition of the State name (*G*, Pl. I).

The numbers stamped on the bench marks described in the following pages represent the elevations to the nearest foot, as determined by the levelman. These numbers are stamped with $\frac{3}{16}$-inch steel dies on the tablets or post caps, to the left of the word "feet." The office adjustment of the notes and the reduction to mean sea-level datum may so change some of the figures that the original markings are 1 or 2 feet in error. It is assumed that engineers and others who have occasion to use the bench-mark elevations will apply to the Director of the United States Geological Survey, at Washington, D. C., for the adjusted values, and will use the markings as identification numbers only.

Datum.—All United States Geological Survey elevations are referred to mean sea level, which is the level that the sea would assume if the influence of tides and winds were eliminated. This level is not the elevation determined from the mean of the highest and the lowest tides, nor is it the half sum of the mean of all the high tides and the mean of all the low tides, which is called the half-tide level. *Mean sea level is the average height of the water, all stages of the tide being considered.* It is determined from observations made by means of tidal gages placed at stations where local conditions, such as long, narrow bays, rivers, and like features, will not affect the height of the water. To obtain even approximately correct results these observations must extend over at least one lunar month, and if accuracy is desired they must extend over several years. At ocean stations the half-tide level and the mean sea level usually differ but little. It is assumed that there is no difference between the mean sea level as determined from observations in the Atlantic Ocean, the Gulf of Mexico, or the Pacific Ocean.

The connection with tidal stations for bench marks in certain areas that lie at some distance from the seacoast is still uncertain, and this fact is indicated by the addition of a letter or word to the right of the word " Datum " on tablets or posts. For such areas corrections for published results will be made from time to time as the precise-level lines of the United States Geological Survey or other Government organizations are extended.

Topographic maps.—Maps of the following quadrangles wholly or partly in New Mexico have been published by the United States Geological Survey up to May 1, 1911. They may be obtained, except as noted, for 5 cents each or $3 a hundred, on application to the Director of the Survey at Washington, D. C.

Albuquerque.
Bernal.
Canyon de Chelly (Ariz.-N. Mex.).
Chaco.
Corazon.
Deming.
Fort Bayard, special (10 cents).
Fort Defiance (Ariz.-N. Mex.).
Gallina.
Jemez.
Lamy.
Largo.
Las Cruces.
Las Vegas.
Mount Taylor.
St. Johns (Ariz.-N. Mex.).
San Pedro.
Santa Clara.
Santa Fe.
Santa Rita, special.
Silver City.
Socorro.
Watrous.
Wingate.

PRECISE LEVELING.

Albuquerque, Engle, Las Cruces, Lajoya, Los Lunas, Rincon, San Marcial, Socorro, and Tonuco Quadrangles.

BERNALILLO, DONA ANA, SIERRA, SOCORRO, AND VALENCIA COUNTIES.

The following are the results for the New Mexico portion of a precise level line run in 1905 by M. S. Bright along the Atchison, Topeka & Santa Fe Railway from Albuquerque, N. Mex., south to El Paso, Tex. The elevations are in accord with the height of a bench mark at Rincon determined by precise leveling from Yuma, and adjusted to the preliminary heights of bench marks near Albuquerque determined by the precise level line of the Coast and Geodetic Survey in 1909. By applying the orthometric correction to the elevations between Rincon and Albuquerque, a close agreement was obtained with the Coast and Geodetic Survey preliminary elevations near Albuquerque.

ALBUQUERQUE QUADRANGLE.

Albuquerque south along Atchison, Topeka & Santa Fe Ry. to San Marcial (portion of line).

	Feet.
Albuquerque, corner of Railroad Avenue and First Street, at northwest corner of Alvarado Hotel grounds, in cement; iron post (Coast and Geodetic Survey, unadjusted value 1910)	4,952.241

	Feet.
Albuquerque, in front of station; top of rail	4,952.9
Albuquerque, southwest corner of Coal and Second Streets, 90 feet west of west end of viaduct over Atchison, Topeka & Santa Fe Ry. tracks, set in cement; iron post (Coast and Geodetic Survey unadjusted value 1910)	4,949.904
Albuquerque, southeast corner of foundation of first pier west of main line of Atchison, Topeka & Santa Fe Ry. under south side of viaduct; cross	4,952.72
Albuquerque, 3.2 miles south of, 60 feet west of track, at third telegraph pole north of gate; iron post (Coast and Geodetic Survey, unadjusted value 1910)	4,930.488

LOS LUNAS QUADRANGLE.

Albuquerque south along Atchison, Topeka & Santa Fe Ry. to San Marcial (portion of line).

Albuquerque, 6.3 miles south of, 900 feet south of milepost 909, 55 feet east of tracks, 18 feet south of gate; iron post (Coast and Geodetic Survey, unadjusted value 1910)	4,927.064
Barr, in front of signboard; top of rail	4,911.7
Isleta, 3 miles north of, west of track, 100 feet northwest of milepost 912, at southeast corner of tool house; top of bolt	4,901.31
Isleta, 3 miles north of, 450 feet north of milepost 912, 600 feet north of section house, 100 feet east of track; iron post (Coast and Geodetic Survey, unadjusted value 1910)	4,903.010
Isleta, 2 miles north of, on north pier of bridge over Rio Grande River east of track; chiseled square	4,900.72
Isleta, in front of station; top of rail	4,896.3
Isleta, 0.2 mile southwest of station, 50 feet west of El Paso line track, 200 feet east of transcontinental line track, 5 feet north of stone post, in cement; iron post (Coast and Geodetic Survey, unadjusted value 1910)	4,890.036
Isleta, 2 miles south of, 500 feet south of milepost 917, on southwest cap of bridge 823; top of bolt	4,871.44
Isleta, 3.5 miles south of, 100 feet north of road crossing, 50 feet west of track; iron post	4,869.532
Los Lunas, 700 feet north of station, 60 feet west of track at road crossing, at northeast corner of Solomon Lunas's yard fence; iron post	4,851.396
Los Lunas, in front of station; top of rail	4,851.8
Los Lunas, 3 miles south of, 50 feet east of track, 10 feet north of gate; iron post	4,832.960
Los Lunas, 5.7 miles south of, 45 feet west of track, at road crossing; iron post	4,821.117
Belen, 1.2 miles north of, 50 feet east of track at road crossing; iron post	4,808.271
Belen, in front of station; top of rail	4,804.0
Belen, 1.7 miles south of, 50 feet west of junction with Belen cutoff, 260 feet south of milepost 934; iron post	4,793.130
Belen, 4.8 miles south of, 220 feet south of milepost 937, 50 feet west of track, 8 feet north of gate; iron post	4,793.673

LAJOYA QUADRANGLE.

Albuquerque south along Atchison, Topeka & Santa Fe Ry. to San Marcial (portion of line).

	Feet.
Sabinal, 1.5 miles north of, 300 feet north of Valencia-Socorro County line, 50 feet west of track, 12 feet north of gate; iron post	4,768.757
Sabinal, in front of signboard; top of rail	4,761.7
Sabinal, 0.5 mile south of, 400 feet south of milepost 943, 45 feet west of track, 6 feet north of gate; iron post	4,761.294
Sabinal, 3.5 miles south of, 500 feet south of milepost 946, 50 feet west of track, 7 feet south of gate; iron post	4,741.941
Sabinal, 6.5 miles south of, 300 feet south of milepost 949, 50 feet east of road crossing at fence corner; iron post	4,739.189
Lajoya, 1.5 miles north of, 3 feet west of milepost 952, 50 feet east of track; iron post	4,718.800
Lajoya, in front of station; top of rail	4,713.0
Lajoya, 4.7 miles south of, 50 feet west of track, at fence line; iron post	4,689.864
Alamillo, 4.2 miles north of, 180 feet west of bridge 886, 50 feet north of track; iron post	4,697.298
Alamillo, 3.5 miles north of, north end of steel bridge 889, 8 feet east of track, at corner of retaining wall; aluminum tablet	4,694.598
Alamillo, 1.8 miles north of, at north end of west guardrail of bridge 889-A; top of bolt	4,670.91

SOCORRO QUADRANGLE.

Albuquerque south along Atchison, Topeka & Santa Fe Ry. to San Marcial (portion of line).

Alamillo, in front of signboard; top of rail	4,664.0
Alamillo, 60 feet south of milepost 965, at northeast corner of fence at section house; iron post	4,652.029
Alamillo, 2.1 miles south of, north end of west guardrail of bridge "898-A"; top of bolt	4,649.0
Alamillo, 3.7 miles south of, 50 feet east of track, at dike; iron post	4,633.630
Lemitar, in front of signboard; top of rail	4,624.3
Socorro, 1.5 miles north of, 800 feet north of milepost 976, 50 feet west of track; iron post	4,596.585
Socorro, in front of station; top of rail	4,587.35
Socorro, in front of Windsor Hotel, in line with curb; iron post	4,592.300
Socorro, 2.5 miles south of, 100 feet north of milepost 980, 50 feet west of track, in fence corner; iron post stamped "SOCR 4568"	4,573.252

SAN MARCIAL QUADRANGLE.

Albuquerque south along Atchison, Topeka & Santa Fe Ry. to San Marcial (portion of line).

Socorro, 5.5 miles south of, 1,000 feet south of milepost 983, 60 feet west of track, 125 feet east of adobe house, 3 feet north of gate; iron post	4,565.034
Socorro, 8.7 miles south of, 1,300 feet south of milepost 986, 50 feet west of track, 2 feet north of gate; iron post	4,547.490

	Feet.
San Antonio, in front of station; top of rail	4,544.5
San Antonio, 150 feet west of track, 6 feet south of southeast corner of Solomon B. Chavez's house; iron post	4,538.585
San Antonio, 2.5 miles south of, 27 feet west of track, at north end of base line, 15 feet north of signal; iron post	4,531.846
San Antonio, 6 miles south of, 60 feet west of track, 4 feet south of milepost 994; iron post	4,508.480
Elmendorf; top of rail	4,507.7
Elmendorf, 1.4 miles south of, in cement under signal at south end of base line; iron post	4,497.784
San Marcial, 6 miles north of, in north end of west guardrail of bridge 938; top of bolt	4,491.95
San Marcial, 5 miles north of, 300 feet south of milepost 1000, 50 feet west of track, at wire fence; iron post	4,488.400
San Marcial, 2.2 miles north of, 1,300 feet north of milepost 1003, 50 feet west of track, 2 feet north of gate; iron post	4,471.536
San Marcial, in front of station; top of rail	4,459.1
San Marcial, northwest corner of railroad park, 3 feet west of northwest gate, set in cement; iron post	4,457.686
San Marcial, northwest corner of railroad park, 3 feet west of northwest gate, set in cement; aluminum tablet	4,457.098
San Marcial, 0.75 mile south of, north end of railroad bridge over Rio Grande River, 4 feet east of rail, in coping stone; aluminum tablet stamped "107"	4,462.130
San Marcial, 4 miles south of, east of track, 60 feet east of road crossing, 10 feet north of wagon road; iron post stamped "110"	4,498.640
Pope, 36 feet east of main line, in line with telegraph poles; iron post stamped "113"	4,581.064
Pope, in front of signboard; top of rail	4,589.6

ENGLE QUADRANGLE.

San Marcial south along Atchison, Topeka & Santa Fe Ry. to Rincon (portion of line.)

Pope, 2.5 miles south of, south of telegraph pole, north of milepost 1015, 40 feet west of track, in line with telegraph poles; iron post stamped "116"	4,642.539
Pope, 5.75 miles south of, one telegraph pole south of milepost 1018, 50 feet west of track, in line with telegraph poles; iron post stamped "119"	4,720.000
Lava, 0.25 mile north of station, 700 feet south of milepost 1021, 50 feet east of track, in line with telegraph poles; iron post stamped "122"	4,720.850
Lava, in front of station; top of rail	4,725.7
Lava, 0.5 mile south of station, on small flat surrounded by volcanic rock and lava, 14 rails south of milepost 1022, 8 rails north of point of curve, 106 feet west of track, under mound of volcanic rock flush with ground, in cement; iron post stamped "123"	4,710.766
Lava, 3.5 miles south of, 45 feet west of track, 5 feet south of milepost 1025; iron post stamped "126"	4,682.845
Lava, 6.5 miles south of, 45 feet west of track, 6 feet south of milepost 1028; iron post stamped "129"	4,650.965

	Feet.
Lava, 9.5 miles south of, 45 feet west of track, 6 feet south of milepost 1031; iron post stamped "132"	4,724.069
Crocker, in front of signboard; top of rail	4,730.0
Crocker, 2 miles south of, 40 feet west of track, south of milepost 1034; iron post stamped "135"	4,785.520
Crocker, 5 miles south of, 40 feet west of track, 6 feet south of milepost 1037; iron post stamped "138"	4,842.820
Crocker, 8 miles south of, 45 feet west of track, 5 feet south of milepost 1040; iron post stamped "141"	4,785.490
Engle, 150 feet north of, between main line and side track of Atchison, Topeka & Santa Fe Ry.; iron post stamped "4727." (Set by Reclamation Service)	4,769.507
Engle, in front of station; top of rail	4,769.7
Engle, 3 miles south of, 45 feet west of track, 5 feet south of milepost 1046; iron post stamped "147"	4,746.082
Engle, 6.25 miles south of, 0.25 mile south of milepost 1049, 700 feet south of lake, 135 feet south of cattle guard, 55 feet east of track, 5 feet south of telegraph pole; iron post in cement stamped "150"	4,693.098
Engle, 6.25 miles south of bench 150, 4 inches west of; aluminum tablet set in cement stamped "150½"	4,692.377
Cutter, in front of signboard; top of rail	4,710.0
Cutter, 0.75 mile south of, 45 feet west of track, 6 feet south of milepost 1052; iron post stamped "153"	4,714.658
Cutter, 3.75 mile south of, 45 feet west of track, 5 feet south of milepost 1055; iron post stamped "156"	4,684.968

RINCON QUADRANGLE.

San Marcial south along Atchison, Topeka & Santa Fe Railway to Rincon (portion of line).

Aleman, in front of signboard; top of rail	4,667.8
Aleman, 1.75 miles south of, 45 feet west of track, 6 feet north of milepost 1058; iron post stamped "159"	4,642.644
Aleman, 4.75 miles south of, 45 feet west of track, 6 feet north of milepost 1061; iron post stamped "162"	4,597.430
Upham, in front of station; top of rail	4,560.0
Upham, 0.75 mile south of, 45 feet west of track, 6 feet north of milepost 1064; iron post stamped "165"	4,548.175
Upham, 3.75 miles south of, 45 feet west of track, 5 feet south of milepost 1067; iron post stamped "168"	4,490.977
Upham, 6.75 miles south of, 45 feet west of track, 5 feet north of milepost 1070; iron post stamped "171"	4,427.527
Upham, 9.25 miles south of, 45 feet west of track, 5 feet south of milepost 1073; iron post stamped "174"	4,361.990
Grama, in front of signboard; top of rail	4,348.0
Grama, 2.25 miles south of, 175 feet south of road crossing, 70 feet west of track, 25 feet west of milepost 1076; iron post stamped "177"	4,261.091
Rincon, 0.75 mile north of, at north end of bridge 1035, 5 feet east of rail, in concrete abutment; aluminum tablet stamped "180"	4,107.701
Rincon, in front of station; top of rail	4,057.91

Rincon south along Atchison, Topeka & Santa Fe Railway to La Tuna (portion of line).

	Feet.
Rincon, at northwest corner of Kingman Street and Railroad Avenue, 10 feet south of L. F. Elliott's storehouse and post office, in cement; iron post stamped "283-B-1905"	4,062.593
Rincon, east side of, aluminum tablet in cement; stamped "283½-B-1905"	4,061.990
Rincon, 3 miles southeast of, midway between milepost 1082 and 1083, 40 feet southwest of track, 5 feet west of gate, on fence line; iron post stamped "286-B-1905"	4,023.843
Detroit, in front of station; top of rail	4,011.9

TONUCO QUADRANGLE.

Rincon south along Atchison, Topeka & Santa Fe Railway to La Tuna (portion of line).

Detroit, 0.5 mile south of, 45 feet southwest of public road crossing, by wire fence, about 300 feet south of milepost 1086; iron post stamped "290-B-1905"	4,011.212
Tonuco, in front of signboard; top of rail	4,002.77
Tonuco, 1.5 miles south of, 100 feet east of track at foot of bluff, 45 feet east of milepost 1089; iron post stamped "293-B-1905"	3,992.251
Tonuco, 4.5 miles south of, north side of canyon, 45 feet east of track, 100 feet east of river, 80 feet northeast of bridge 55; iron post stamped "296-B-1905"	3,988.292

LAS CRUCES QUADRANGLE.

Rincon south along Atchison, Topeka & Santa Fe Railway to La Tuna (portion of line).

Tonuco, 7.5 miles south of, about 0.75 mile north of Selden, 100 feet east of track, 45 feet east of milepost 1905, by wire fence; iron post stamped "299-B-1905"	3,967.683
Selden, in front of signboard; top of rail	3,966.0
Selden, 1 mile south of, about 1 mile north of old Fort Selden, in rock which projects about 40 feet out into river; aluminum tablet stamped "3932" (Reclamation Service bench mark)	3,971.858
Selden, 3.75 miles south of, on fence line midway between old and new railroad grade about 200 feet north of the intersection of the two grades; iron post stamped "303-B-1905"	3,955.934
Stewart ranch, 900 feet south of house, 95 feet northeast of public road crossing, 5 feet west of fence corner, on west side of wagon road; iron post stamped "306-B-1905"	3,968.736
Stewart ranch, 2.5 miles south of, 400 feet south of milepost 1105, 40 feet west of road crossing, 7 feet south of gate, on fence line; iron post stamped "309-B-1905"	3,931.313
Dona Ana, in front of station; top of rail	3,919.89
Dona Ana, 1 mile south of, about 500 feet south of milepost 1108, 700 feet northeast of two-story brick house, north side of lane, 45 feet east of road crossing, 6 feet west of fence corner; iron post stamped "312-B-1905"	3,912.409

	Feet.
Dona Ana, 4 miles south of, 300 feet north of milepost 1111, 45 feet east of road crossing, 6 feet north of fence corner; iron post stamped "315-B-1905"	3,899.575
Las Cruces, in front of station; top of rail	3,894.99
Las Cruces, 180 feet south of station, 15 feet west of main track, 12 feet north of water tank, in center of driveway; iron post stamped "3855" (set by Reclamation Service)	3,895.175
Las Cruces, 130 feet southwest of Dona Ana County courthouse, 30 feet east of fence corner; iron post stamped "3855" (set by Reclamation Service)	3,895.263
Las Cruces, City Park, 5 feet west of southeast corner of entrance, set in cement; iron post stamped "318-B-1905"	3,893.034
Mesilla Park, in front of station; top of rail	3,877.422
Mesilla Park, 450 feet south of station, midway between main track and side track; iron post stamped "3837"	3,877.304
Mesilla Park, 2.75 miles south of, 200 feet southeast of milepost 1118, 45 feet west of road crossing, 4 feet east of fence corner; iron post stamped "323-B-1905"	3,865.300
Mesilla Park, 4.75 miles south of, 40 feet east of track, 10 feet northwest of milepost 1120; iron post stamped "3813"	3,853.404
Mesilla Park, 7.75 miles south of, 60 feet east of track, 15 feet east of milepost 1123; iron post stamped "328-B-1905"	3,842.539
Mesquite, in front of signboard; top of rail	3,839.09
Mesquite, 38 feet east of main line, 7 feet north of milepost 1124; iron post stamped "3794"	3,834.547
Mesquite, 3 miles south of, 100 feet northeast of milepost 1127, 90 feet east of road crossing, 6 feet south of gate; iron post stamped "332-B-1905"	3,822.785
Vado, in front of station; top of rail	3,824.91
Vado, 100 feet south of station, in southeast corner of foundation stone under water tank; aluminum tablet stamped "3782"	3,822.720
Berino, 0.25 mile south of milepost 1131, 100 feet east of main line, at west end of lane, 6 feet south of fence corner; iron post stamped "336-B-1905"	3,801.986
Berino, in front of signboard; top of rail	3,798.21
Berino, 0.75 mile south of, 45 feet east of track, 10 feet north of milepost 1132; iron post stamped "3760"	3,800.736
Berino, 3.25 miles south of, 100 feet west of road crossing, 6 feet east of fence corner; iron post stamped "340-B-1905"	3,793.577
La Tuna, in front of signboard; top of rail	3,793.79
La Tuna, 33 feet west of main line, about 4 feet north of line between New Mexico and Texas; iron post stamped "3780"	3,791.743

Deming, Rincon, Separ, and Silver City Quadrangles.

DONA ANA, GRANT, AND LUNA COUNTIES.

The following are the unadjusted results of a line of precise levels along the Atchison, Topeka & Santa Fe Railway from Rincon west to Deming, thence northwest to Silver City. The elevations are based on precise leveling of 1905, 1906, and 1907, from Yuma, Ariz., to Deming, N. Mex.

The leveling was done in 1905 by M. S. Bright.

RINCON QUADRANGLE.

Rincon west along Atchison, Topeka & Santa Fe Railway to Deming, thence northwest to Silver City (portion of line).

	Feet.
Rincon, 2.25 miles southwest of, 45 feet west of track at public road crossing, 4 feet south of milepost 1082; iron post stamped "183"	4,038.171
Hatch, in front of station; top of rail	4,053.03
Hatch, 320 feet southwest of station, 95 feet southwest of track, at fence corner; iron post stamped "186"	4,050.973
Hatch, 3 miles southwest of, 100 feet east of milepost 1088, 40 feet east of track; iron post stamped "189"	4,212.735
Hatch, 6 miles south of, 45 feet west of track, 3 feet west of milepost 1091; iron post stamped "192"	4,366.648
Hockett, 50 feet west of track, 5 feet south of milepost 1094, in front of section house; iron post stamped "195"	4,512.278
Hockett, 3 miles south of, 45 feet west of track, 5 feet north of milepost 1097; iron post stamped "198"	4,483.521
Hockett, 6 miles south of, 40 feet east of track, opposite milepost 1100; iron post stamped "201"	4,491.682
Easley, in front of sign board; top of rail	4,516.13
Easley, 2 miles west of, 75 feet north of track, 30 feet east of milepost 1103; iron post stamped "204"	4,607.728
Nutt, 260 feet south of station, 234 feet south of south rail in main line, 40 feet east of gate near wire fence, in concrete; iron post stamped "206"	4,718.486
Nutt, 260 feet south of station, 234 feet south of south rail on main line, 40 feet east of gate near wire fence, set in cement 4 inches from above bench mark; aluminum tablet stamped "206"	4,717.963
Nutt, 3 miles south of, 165 feet south of milepost 1108, 45 feet west of track, 6 feet north of telegraph pole; iron post stamped "208"	4,652.021

DEMING QUADRANGLE.

Rincon west along Atchison, Topeka & Santa Fe Railway to Deming, thence northwest to Silver City (portion of line).

Nutt, 6 miles south of, 45 feet west of track, 4 feet south of milepost 1111; iron post stamped "211"	4,610.256
Nutt, 9 miles south of, 45 feet west of track, 6 feet north of milepost 1114; iron post stamped "214"	4,583.268
Nutt, 12 miles south of, 45 feet west of track, 6 feet north of milepost 1117; iron post stamped "217"	4,523.648
Florida, in front of signboard, top of rail	4,505.32
Florida, 2 miles south of, 45 feet west of track, 6 feet north of milepost 1120; iron post stamped "220"	4,482.705
Florida, 5.2 miles south of, about 0.25 mile south of milepost 1123, at north end of cut, 80 feet east of track, 12 feet west of wagon road, near wire fence; iron post stamped "223"	4,411.703
Mirage siding; top of rail	4,377.53
Mirage siding, 3 miles south of, 45 feet west of track, 6 feet north of milepost 1129; iron post stamped "229"	4,332.711
Deming, 210 feet north of second switch block in station, Topeka & Santa Fe Railway yards, then 100 feet east of main line, 200 feet southeast of milepost 1132, at fence corner; iron post stamped "232"	4,325.157

	Feet.
Deming, in front of Atchison, Topeka & Santa Fe Railway station; top of rail	4,335.553
Deming, in front of Southern Pacific Railroad station; top of rail	4,335.81
Deming, at southwest corner of Silverton and Railroad Avenues, at corner of concrete sidewalk, in concrete; iron post stamped "233"	4,334.928
Deming, city water works, 222 feet south of Southern Pacific Railroad track, in northwest corner of foundation stone; aluminum tablet stamped "234"	4,345.802
Deming, 3 miles northwest of, 45 feet north of track, 6 feet east of milepost 1136; iron post stamped "236"	4,376.552
Deming, 6 miles northwest of, 90 feet northeast of track, 50 feet northeast of wagon road, 30 feet northeast of milepost 1139; iron post stamped "239"	4,451,165
Deming, 9 miles northwest of, 75 feet northeast of track, 35 feet northeast of milepost 1142 and wagon road; iron post stamped "242"	4,530.022
Deming, 12 miles northwest of, 90 feet northeast of track, 45 feet northeast of milepost 1145 and wagon road; iron post stamped "245"	4,610.191
Deming, 15 miles northwest of, five telegraph poles west of milepost 1148, 80 feet north of bridge 4, at fence corner; iron post stamped "248"	4,672.429
Crawford, in front of signboard; top of rail	4,728.01
Crawford, 0.5 mile northwest of, 75 feet north of track, 30 feet north of milepost 1151; iron post stamped "251"	4,738.973

SEPAR QUADRANGLE.

Rincon west along Atchison, Topeka & Santa Fe Ry. to Deming, thence northwest to Silver City (portion of line).

Crawford, 3.5 miles northwest of, 45 feet north of milepost 1154, 5 feet north of wagon road; iron post stamped "254"	4,806.387

SILVER CITY QUADRANGLE.

Rincon west along Atchison, Topeka & Santa Fe Ry. to Deming, thence northwest to Silver City (portion of line).

Faywood, 340 feet east of station, 45 feet north of road crossing, 7 telegraph poles west of milepost 1157; iron post stamped "257"	4,910.751
Faywood, in front of station; top of rail	4,914.47
Faywood, 3 miles west of, 95 feet south of milepost 1160, 55 feet south of track, 30 feet north of wagon road; iron post stamped "260"	5,000.982
Faywood, 6 miles west of, 110 feet south of milepost 1163, 70 feet south of track, 1 mile east of White Water, 18 feet north of wagon road; iron post stamped "163"	5,128.36
White Water, in front of station at milepost 1164; top of rail	5,156.77
White Water, 700 feet northwest of station, 85 feet south of junction of Silver City-Deming and White Water-Hanover roads, 21 feet south of wagon roads, in limestone rock, aluminum tablet stamped "264-B-1905"	5,157.825
White Water, 3 miles northwest of, 500 feet east of milepost 1167, 65 feet north of bridge 23, on point of ridge; iron post stamped "267-B-1905"	5,210.045

	Feet.
White Water, 6 miles northwest of, opposite milepost 1170, 75 feet south of track, 17 feet south of wagon road, near wire fence; iron post stamped "270-B-1905"	5,319.618
White Water, 9 miles northwest of, 150 feet west of milepost 1173, 80 feet south of track; iron post stamped "273-B-1905"	5,477.339
White Water, 12 miles west of, 210 feet east of steel railroad bridge 38, 65 feet north of track, on hillside; iron post stamped "276-B-1905"	5,611.782
Hawkins, in front of signboard; top of rail	5,703.87
Silver City, 1 mile south of Atchison, Topeka & Santa Fe Ry. station, 475 feet north of steel bridge 40, 45 feet east of track, 45 feet north of milepost 1179; iron post stamped "279-B-1905"	5,766.390
Silver City, in front of Atchison, Topeka & Santa Fe Ry. station; top of rail	5,866.97
Silver City, in south end of first stone step at front entrance to Silver City National Bank; aluminum tablet stamped "281-B-1905"	5,879.185
Silver City, Grant County courthouse, in northeast corner of base stone; aluminum tablet stamped "5932-PHNX-1902"	5,931.378

Deming, Lordsburg, Separ, and San Simon Quadrangles.

GRANT AND LUNA COUNTIES.

The following are the unadjusted results of a line of precise levels along the Southern Pacific Railroad from Deming west to the Arizona-New Mexico boundary line. The elevations are based upon precise leveling in Arizona brought from Yuma.

The leveling was done in the winter of 1906–1907 by A. R. Carver and W. A. E. Hult.

DEMING QUADRANGLE.

Deming west along Southern Pacific R. R. to Arizona-New Mexico line (portion of line).

	Feet.
Milepost 1203, 100 feet south of, 20 feet north of wagon road; iron post stamped "4-C-1906"	4,382.608
Parma, opposite milepost 1202; top of rail	4,393.4
Parma, 2 miles west of, 100 feet south of milepost 1200, 50 feet north of wagon road; iron post stamped "7-C-1906"	4,410.588
Tunis, in front of signboard; top of rail	4,423.8
Tunis, 1.25 miles west of, 100 feet south of milepost 1197, 15 feet north of wagon road; iron post stamped "10-C-1906"	4,434.155
Tunis, 4.25 miles west of, 20 feet north of wagon road, 75 feet south of milepost 1194; iron post stamped "13-C-1906"	4,422.177

SEPAR QUADRANGLE.

Deming west along Southern Pacific R. R. to Arizona-New Mexico line (portion of line).

Mongola, in front of signboard; top of rail	4,430.2
Mongola, 0.9 mile west of, 100 feet south of track, 15 feet north of wagon road, 75 feet south of milepost 1191; iron post stamped "16-C-1906"	4,435.946

	Feet.
Gage, 1 mile east of, 110 feet south of track, 15 feet north of road, 75 feet south of milepost 1188; iron post stamped "19–C–1906"	4,479.401
Gage, in front of; top of rail	4,489.2
Gage, 2 miles west of, 100 feet south of track, 30 feet north of wagon road at grade crossing; iron post stamped "22–C–1906"	4,530.170
Aitkin, in front of signboard; top of rail	4,563.8
Aitkin, 40 feet north of wagon road, 75 feet south of milepost 1182; iron post stamped "25–C–1906"	4,560.536
Wilna, 0.8 mile east of, 75 feet south of milepost 1179, 30 feet north of wagon road; iron post stamped "28–C–1906"	4,557.126
Wilna, in front of signboard; top of rail	4,559.7
Wilna, 2 miles west of, 75 feet south of milepost 1176, 30 feet north of wagon road; iron post stamped "31–C–1906"	4,579.753
Continental Divide; top of rail	4,586.5
Wilna, 5 miles west of, 75 feet south of milepost 1173, 30 feet north of road; iron post stamped "34–C–1906"	4,550.750
Ladim, in front of signboard; top of rail	4,553.5
Ladim, 2.5 miles west of, 100 feet south of track, 15 feet north of wagon road, 75 feet south of milepost 1170, at fence corner; iron post stamped "37–C–1906"	4,506.439
Separ, 90 feet south of track, in southeast corner of station yard; iron post stamped "40–C–1906"	4,504.866
Separ, in front of station; top of rail	4,505.5
Separ, 2.8 miles west of, 100 feet south of track, 15 feet north of wagon road, 75 feet south of milepost 1164; iron post stamped "43–C–1906"	4,468.301
Hawkins, in front of signboard; top of rail	4,457.6

LORDSBURG QUADRANGLE.

Deming west along Southern Pacific Railroad to Arizona-New Mexico line (portion of line).

Hawkins, 2 miles west of, 100 feet south of track, 75 feet south of milepost 1161, 15 feet north of wagon road; iron post stamped "46–C–1906"	4,393.384
Lisbon, 0.5 mile east of, 100 feet south of track, 40 feet north of wagon road, 75 feet south of milepost 1158; iron post stamped "49–C–1906"	4,290.733
Lisbon, in front of signboard; top of rail	4,280.8
Lisbon, 2.5 miles west of, 100 feet south of track, 75 feet north of road, 75 feet south of milepost 1155; iron post stamped "52–C–1906"	4,235.105
Ulmoris, 0.5 mile east of, 100 feet south of track, 15 feet south of road, 75 feet south of milepost 1152; iron post stamped "55–C–1906"	4,209.237
Ulmoris, in front of signboard; top of rail	4,207.9
Lordsburg, 2 miles east of, 100 feet south of track, 75 feet north of wagon road, 75 feet south of milepost 1149; iron post stamped "58–C–1906"	4,218.912
Lordsburg, midway between stores of Charley Lee and Roberts & Leahy Co.; iron post stamped "67–C–1906"	4,249.781
Lordsburg, in front of station; top of rail	4,247.1
Lordsburg, junction with Arizona & New Mexico Ry.; top of rail	4,260.0

	Feet.
Lordsburg, 3 miles west of, 75 feet south of milepost 1144, 20 feet north of road; iron post stamped "63-H-1907"	4,266.421
Pyra, in front of signboard; top of rail	4,302.2
Pyra, 1.5 miles west of, 75 feet south of milepost 1141, 10 feet south of road; iron post stamped "66-H-1907"	4,282.214
Gary siding; top of rail	4,222.6
Gary siding, 1.5 miles west of, 75 feet south of milepost 1138, 15 feet north of road; iron post stamped "69-H-1907"	4,153.961
Conrad, in front of signboard; top of rail	4,149.9
Conrad, 1.1 miles west of, 75 feet south of milepost 1134, 1,000 feet north of wagon road; iron post stamped "73-H-1907"	4,148.069
Mondel, in front of signboard; top of rail	4,155.7
Mondel, 0.25 mile west of, 75 feet south of milepost 1131, 10 feet south of road; iron post stamped "76-H-1907"	4,155.576
Steins Pass, at northwest corner of William Charles's store, iron post stamped "80-H-1907"	4,346.485
Steins Pass, in front of station; top of rail	4,351.5

SAN SIMON QUADRANGLE.

Deming west along Southern Pacific Railroad to Arizona-New Mexico line (portion of line).

Steins Pass, 3.5 miles west of, 75 feet south of milepost 1124; iron post stamped "84-½-H-1907"	4,115.301
Cavot siding, on Arizona and New Mexico line; top of rail	4,099.3

Abiquiu, Albuquerque, Cabezon, Gallina, Jemez, and Laguna Quadrangles.

BERNALILLO, RIO ARRIBA, AND SANDOVAL COUNTIES.

The following are the unadjusted results of precise leveling from Albuquerque to Cuba and from a point near Coyote to Espanola. These two lines are connected between Cuba and Coyote by primary circuits in the Gallina quadrangle, given in another list. The elevations are based upon preliminary results of precise leveling of the Coast and Geodetic Survey, near Albuquerque.

The leveling was done in 1905 by M. S. Bright.

ALBUQUERQUE QUADRANGLE.

Albuquerque along highway northwest to Cabezon, thence northeast to Cuba (portion of line).

	Feet.
Albuquerque, at southwest corner of Coal and Second streets, 90 feet west of west end of viaduct over Atchison, Topeka & Santa Fe Ry. tracks, in cement; iron post stamped "1" (unadjusted value Coast and Geodetic Survey 1910)	4,949.904
Albuquerque, in west root of first cottonwood tree east of bridge over Rio Grande; nail	4,941.70
Albuquerque, 2 miles west of, at west end of lane, 40 feet south of fence corner, in north root of 18-inch cottonwood tree; nail	4,942.77
Albuquerque, 3 miles west of, 160 feet southwest of bridge over canal, in south side of 8-inch cottonwood tree on fence line; spike	4,942.46

	Feet.
Albuquerque, 3 miles west of, 100 feet southwest of bridge over canal, near wire fence, on south side of road; iron post stamped "4½"	4,943.222
Albuquerque, 3.5 miles west of, 100 feet east of foothills, on east side of road, in west root of 20-inch cottonwood tree; spike	4,946.29
Albuquerque, 6.5 miles west of, in west forks of crossroads; iron post stamped "8½"	5,219.221
Albuquerque, 9.2 miles west of, 100 feet south of road in small draw, on black bowlder outcrop; paint point in circle	5,632.18
Albuquerque, 9.8 miles west of, in road forks; iron post stamped "12¼"	5,751.754
Albuquerque, 11.8 miles northwest of, 13 feet west of road, on open flat; iron post stamped "14"	5,808.607
Albuquerque, 15.25 miles northwest of, 45 feet north of old east and west road, 15 feet west of main north and south road, on north side of draw; iron post stamped "18"	5,854.985
Albuquerque, 17.8 miles northwest of, 40 feet south of road, on north edge of draw, in west root of scrub cedar tree; nail	5,900.36
Albuquerque, 18.25 miles northwest of, 60 feet west of draw, 15 feet west of road; iron post stamped "21"	5,959.520
Albuquerque, 21.75 miles northwest of, on north side of draw, 10 feet west of cedar tree, on east side of road; iron post stamped "24"	6,227.948
Albuquerque, 23.25 miles northwest of, 10 feet west of road, 30 feet east of cedar tree; iron post stamped "26"	6,284.800
Albuquerque, 25.8 miles northwest of, 60 feet west of forks of five roads; iron post stamped "29"	6,351.568
Albuquerque, 26.25 miles northwest of, in flat wash, on north edge of road, in south side of 20-inch scrub cedar tree; nail	6,270.22
Cottonwood Spring, about 0.4 mile northwest of, on ridge, 100 feet north of road; iron post stamped "33"	6,030.000
Cottonwood Spring, 3.8 miles west of, 400 feet northeast of sandstone bluffs, 10 feet south of road; iron post stamped "36"	5,672.558

LAGUNA QUADRANGLE.

Albuquerque along highway northwest to Cabezon, thence northeast to Cuba (portion of line).

Navajo Springs, 3 miles west of, 60 feet north of road forks in sandstone outcrop; aluminum tablet stamped "40"	5,577.313
Navajo Springs, 5.25 miles northwest of, about 800 feet northeast of old rock dam, 25 feet south of road, on southwest end of ridge; iron post stamped "42"	5,617.040
Navajo Springs, 6.8 miles northwest of, 15 feet northeast of road, on top of sandstone ridge; chiseled point in center of painted circle	5,649.93
Navajo Springs, 8.25 miles northwest of, 15 feet north of road, on sandy flat; iron post stamped "46"	5,661.819
Navajo Springs, 11.25 miles northwest of, 12 feet west of road, on west spur of hill; iron post stamped "49"	5,708.349
Navajo Springs, 14.8 miles northwest of, 30 feet east of road, on east edge of river bottom, 100 feet west of old rock corral, on point of ridge; iron post stamped "53"	5,753.903
Casa Salazar, 0.2 mile east of, in forks of road leading to Casa Salazar and Cabezon, about 900 feet east of ford; iron post stamped "55"	5,791.547

CABEZON QUADRANGLE.

Albuquerque along highway northwest to Cabezon, thence northeast to Cuba (portion of line).

	Feet.
Casa Salazar, 2.8 miles north of, 800 feet south of small corral, 12 feet west of road, on south side of slight slope; iron post stamped "58"	5,838.427
Casa Salazar, 5.5 miles north of, east side of road, at point where road leaves canyon and turns right angle to east, in standstone ledge; aluminum tablet stamped "61"	5,934.500
Casa Salazar, 7.5 miles north of, 20 feet west of road forks, on west spur of ridge; iron post stamped "64"	6,202.887
Casa Salazar, 10.25 miles north of, 25 feet east of road, on west spur of ridge, east side of draw; iron post stamped "67"	6,193.448
Cabezon, 1 mile north of, top of flat ridge in road forks; iron post stamped "70"	6,153.323
Cabezon, 3.8 miles north of, 250 feet east of road forks, west toe of knoll; iron post stamped "73"	6,194.460
Cabezon, 7.25 miles north of, 150 feet east of river, 50 feet east of road, on west point of ridge; iron post stamped "76"	6,271.894
Cabezon, 11 miles north of, 15 feet west of road, on rock ridge; iron post stamped "79½"	6,359.431
Cabezon, 14 miles north of, 8 feet east of old road, in gap 500 feet east of new road; iron post stamped "82"	6,580.943

JEMEZ QUADRANGLE.

Albuquerque along highway northwest to Cabezon, thence northeast to Cuba (portion of line).

Cabezon, 17.25 miles north of, 1,000 feet north of road forks, 20 feet east of road, at foot of sandstone bluff; iron post stamped "85"	6,537.504
Cabezon, 20.25 miles north of, 150 feet east of river, 6 feet west of road, in sandstone rock about 3 feet square; aluminum tablet stamped "88"	6,583.369
Cabezon, 23.5 miles north of, on west point of small hill between two flat draws, 10 feet east of road, at a point where road makes angle from east to northwest; iron post stamped "91"	6,760.987
Cabezon, 24.8 miles north of, 15 feet east of road, on ridge, in north root of 8-inch pinyon tree; nail	6,801.88
Cabezon, 26.8 miles north of, on flat ridge, in road forks; iron post stamped "94"	6,716.627
Cabezon, 27.8 miles north of, 60 feet north of road, about 400 feet east of house, in west root of 20-inch double cedar tree; nail	6,743.37
Little Lake, at top of ridge, 14 feet east of road, 200 feet west of house; iron post stamped "97"	6,800.180
Little Lake, 1.5 miles north of, 30 feet east of road forks, on point of ridge, in west root of 22-inch pine tree; nail	6,841.20
Little Lake, 2.8 miles north of, 60 feet below dam, on east side of draw, in top of 18-inch cottonwood stump; nail	6,863.98

GALLINA QUADRANGLE.

Point 9 miles northeast of Coyote southeast along highway to Espanola (portion of line).

	Feet.
Gallezos ranch, about 4.5 miles southeast of, northeast side of cross-roads, mound on north and pit on east; aluminum tablet stamped "198½"	6,528.719

ABIQUIU QUADRANGLE.

Point 9 miles northeast of Coyote southeast along highway to Espanola.

Canjilon Creek, 3.2 miles west of, 55 feet west of Coyote and Abiquiu wagon road, on top of flat ridge, in volcanic rock; aluminum tablet stamped "214"	6,502.541
Canjilon Creek, 150 feet east of, south side of Chama River, on south edge of wagon road and railroad grade, in sandstone rock; aluminum tablet stamped "218"	6,065.689
Canjilon Creek, 0.5 mile east of, south side of Chama River, south edge of road, on sandstone rock; center of paint circle	6,068.13
Canjilon Creek, 3 miles east of, about 600 feet south of adobe house, 200 feet south of railroad grade, 16 feet north of wagon road, in sandstone rock; aluminum tablet stamped "221"	6,025.248
San Francisco, 1.8 miles east of, north side of river, about 400 feet north of old adobe ruins, in road forks, set in sandstone rock; aluminum tablet stamped "224"	6,018.673
Abiquiu, 1.5 miles east of, 125 feet west of old adobe ruins, 12 feet south of road, set in sandstone; aluminum tablet stamped "227," mound of rock around tablet	5,972.587
Miller ranch house, 500 feet southwest of, 70 feet southwest of fence corner 30 feet south of road, in volcanic bowlder; aluminum tablet stamped "230"	5,919.563
Tierra Azul, 1 mile east of, 150 feet west of wash, south side of road, in volcanic rock; aluminum tablet stamped "233"	5,871.602
Tierra Azul, 3.8 miles east of, south side of road, 150 feet east of forks, in scrub cedar tree; nail	5,858.13
Tierra Azul, 4.5 miles southeast of, 150 feet east of wash, 12 feet west of road, at foot of rocky hills, set in bowlder outcrop; aluminum tablet stamped "237"	5,817.699
Tierra Azul, 5.8 miles southeast of, on edge of river bottom, 115 feet north of railroad grade and road forks, in west side of 30-inch cottonwood tree; nail	5,765.84
J. D. Herrara ranch, 120 feet west of house, 60 feet west of road, 60 feet north of new foundation for house, at foot of hills, in sandstone rock; aluminum tablet stamped "240"	5,749.772
Herrara ranch, 1 mile southeast of, at head of lane, 70 feet west of road forks, in west side of 16-inch cottonwood tree; nail	5,718.91
Gallegos ranch, 35 feet west of house, on east side of road, at fence corner, in sandstone rock; aluminum tablet stamped "243"	5,695.430
B. Salazar ranch, 160 reet south of house, 20 feet east of road, at fence corner, in volcanic bowlder; aluminum tablet stamped "247"	5,641.541
Espanola, in northeast corner foundation stone of Bond & Bros.' warehouse; aluminum tablet stamped "251"	5,582.813
Espanola, in front of station; top of rail	5,584.5
C. L. Pallard's storehouse and post office, 60 feet east of, 10 feet south of fence corner, in volcanic rock; aluminum tablet stamped "252"	5,582.398

PRIMARY LEVELING.

Silver City Quadrangle, including Fort Bayard Special Quadrangle.

GRANT COUNTY.

The elevations in the following list are based on a line of precise levels run in 1905 from San Marcial to Silver City, traversing this quadrangle. For additional elevations in this quadrangle refer to the list for precise leveling, page 15.

Most of the leveling was done in 1902 and 1903 by Chester Irvine, and in 1907 by Victor Mindeleff, jr. The leveling in the Fort Bayard Military Reservation was done in 1908 by Stuart T. Penick.

SILVER CITY QUADRANGLE.

Mouth of Fleming Canyon southeast to Silver City.

	Feet.
T. 17 S., R. 16 W., sec. 35, mouth of Fleming Canyon, 15 feet south of road; iron post stamped "4980 PHNX"	4,978.991
T. 18 S., R. 15 W., sec. 6, 2.5 miles east of Culberson ranch, 60 feet south of junction of roads, on summit of ridge; bronze tablet stamped "5326 PHNX"	5,325.351
T. 18 S., R. 15 W., sec. 11, 6 miles west of Silver City, 20 feet north of junction of roads at "Cut-of-troughs"; bronze tablet stamped "5878 PHNX 1902"	5,877.482

Small circuit east to Silver City and return.

T. 18 S., R. 14 W., sec. 7, 4 miles west of Silver City, summit of Continental Divide, 10 feet north of road; bronze tablet stamped "6219 PHNX 1902"	6,218.340
T. 18 S., R. 14 W., sec. 10, 0.8 mile south of Silver City, 20 feet east of road, on Iron Hill; bronze tablet stamped "6052 PHNX 1902"	6,051.092
Silver City, T. 18 S., R. 14 W., sec. 3, northeast corner of courthouse, stone foundation; aluminum tablet stamped "5932 PHNX 1902"	5,931.378

Road junction 6 miles west of Silver City southwest via Wind Canyon to Foraker ranch (main line continued).[1]

T. 18 S., R. 15 W., sec. 8, 3 miles northeast of McMillan upper ranch, north side of and in bend of Wind Canyon, large bowlder; bronze tablet stamped "5431 PHNX 1902"	5,431.227
T. 18 S., R. 16 W., sec. 24, 400 feet south of McMillan upper ranch, 40 feet south of road, on slope of ridge; bronze tablet stamped "5166 PHNX 1902"	5,166.415
T. 18 S., R. 16 W., sec. 35, 300 feet east of corral, Foraker ranch, 30 feet east of road, on small rocky knoll; bronze tablet stamped "5773 PHNX 1902"	5,772.983

Silver City northeast and north via Pinos Altos to Sapello Creek.

T. 17 S., R. 14 W., sec. 35, 2.05 miles north of Silver City, junction of Silver City-Pinos Altos and Silver City-Santa Rita roads; iron post stamped "6080 PHNX"	6,078.871

[1] An adjustment of 1 foot thrown in this line to satisfy 1907 work.

	Feet.
T. 17 S., R. 14 W., sec. 13, 5.48 miles north of Silver City, 20 feet north of road on summit of ridge southwest of drains; bronze tablet stamped "6582 PHNX"	6,580.517
T. 17 S., R. 13 W., sec. 6, Pinos Altos, east side of road, southwest corner of Oglesby's residence lot; iron post stamped "7041 PHNX"	7,039.877
T. 16 S., R. 14 W., sec. 25, 0.25 mile northeast of Mountain K mill, forks of road at mouth of Little Cherry Creek, 40 feet west of sawmill road, north bank of Cherry Creek; bronze tablet stamped "6569 PHNX"	6,568.096
T. 16 S., R. 13 W., sec. 8, 3.85 miles northeast of Mountain K mill, mouth of small creek, forks of road, north side of Cherry Creek; aluminum tablet stamped "6959 PHNX"	6,957.798
T. 15 S., R. 13 W., sec. 32, 2 miles north of Scott's old mill stand, 40 feet west of road, south side of saddle, limestone ledge leaning east and west; aluminum tablet stamped "7431 PHNX"	7,429.554
T. 15 S., R. 13 W., sec. 20, 2 miles north of Trout Creek mill, east side of road on ridge, stone monument, 3 by 3½; bronze tablet stamped "7211 PHNX"	7,209.531

McMillan upper ranch south to Allen ranch, thence east to White Water (mean of direct and reverse lines).

T. 18 S., R. 15 W., sec. 32, 2.73 miles south of White Hill Wells, 600 feet east of "76" corral, 50 feet east of road, in bowlder; aluminum tablet stamped "5342"	5,342.537
T. 19 S., R. 15 W., sec. 10, 0.4 mile south of Bell ranch, in forks of road; iron post stamped "5654"	5,654.920
Leopold, T. 19 S., R. 15 W., sec. 22, midway between company store and hotel, 5 feet east of road; iron post stamped "6141"	6,142.033
Brown's store, sec. 34, T. 19 S., R. 15 W., 375 feet south of store, in road forks, in bowlder; aluminum tablet stamped "6275"	6,275.655
T. 19 S., R. 14 W., sec. 31, 4.59 miles north of Allen ranch, 400 feet east of road, on ridge, at north and south fence line, in bowlder; aluminum tablet stamped "6015"	6,016.586
T. 20 S., R. 15 W., sec. 12, 2.70 miles north of Allen ranch, 200 feet south of arroyo, 100 feet west of road, in limestone outcrop; aluminum tablet stamped "6054"	6,054.997
T. 20 S., R. 14 W., southwest corner of sec. 16, 4.57 miles east of Allen ranch, 25 feet north of road, southwest corner of school section; iron post stamped "5762"	5,762.544
T. 20 S., R. 14 W., sec. 23, 7.87 miles west of White Water, 300 feet west of road crossing, 100 feet north of road, in bowlder; aluminum tablet stamped "5591"	5,591.945
T. 20 S., R. 13 W., sec. 20, 4.84 miles west of White Water, 10 feet north of road, in bowlder; aluminum tablet stamped "5382"	5,382.865
T. 20 S., R. 13 W., sec. 15, 2.91 miles west of White Water, top of ridge just east of Cherry Creek, 15 feet south of road, in bowlder; aluminum tablet stamped "5257"	5,258.108

Allen ranch west 6 miles and return.

T. 20 S., R. 15 W., sec. 22, 600 feet west of Allen ranch house, 50 feet north of road; iron post stamped "6028"	6,029.073
T. 20 S., R. 15 W., sec. 20, 3.19 miles west of Allen ranch, 75 feet north of road forks, in bowlder; aluminum tablet	6,273.611

	Feet.
T. 20 S., R. 16 W., sec. 36, 5.95 miles west of Allen ranch, in road forks, 75 feet west of east road, 150 feet east of west road, 500 feet south of forks, in bowlder; aluminum tablet	6,180.480

Silver City along highway east to Fort Bayard, thence south to Central, thence east to Hanover Junction.

T. 17 S., R. 13 W., sec. 32, 5.07 miles northeast of Silver City, 50 feet west of junction of Silver City—Fort Bayard road and Silver City—Central roads, in bowlder; iron post stamped "6110"	6,110.372
Fort Bayard astronomical station, sec. 26, T. 17 S., R. 13 W., in monument; aluminum tablet stamped "6165"	6,164.757
T. 17 S., R. 12 W., sec. 31, 1.34 miles east of Central, 60 feet north of road, 150 feet east of arroyo, on small knoll, in bowlder; aluminum tablet stamped "6068"	6,068.015

White Water north along Atchison, Topeka & Santa Fe Ry. to Fierro, thence north 1 mile and return to Hanover.

T. 19 S., R. 13 W., sec. 25, 1.37 miles south of Apache Tejo, 62.5 feet south of milepost 1167, 215 feet east of track, in bowlder; aluminum tablet stamped "5302"	5,302.356
T. 19 S., R. 12 W., sec. 7, 1.82 miles north of Apache Tejo (Old Fort McLane), 400 feet north of milepost 1170, 10 feet west of track, in bowlder; aluminum tablet stamped "5510"	5,510.073
Hurley, sec. 25, T. 18 S., R. 13 W., 100 feet south of derail target, 50 feet east of track, in bowlder; aluminum tablet stamped "5748"	5,747.748
T. 18 S., R. 13 W., sec. 13, 1.10 miles south of Bayard, 150 feet west of railroad trestle 5, 75 feet south of road to Central, in bowlder; aluminum tablet stamped "5748"	5,748.299
Bayard, opposite waiting room entrance; top of rail	5,824.2
Hanover Junction, sec. 32, T. 17 S., R. 12 W., 450 feet east of junction of rails midway between rails, 15 feet north of wagon road, in bowlder; aluminum tablet stamped "5959"	5,959.075
Hanover, 125 feet north of station, T. 17 S., R. 12 W., sec. 21, 30 feet east of track, 5 feet west of wagon road, 100 feet south of arroyo at road crossing, in bowlder; aluminum tablet stamped "6367"	6,366.866
Hanover, in front of station; top of rail	6,361.3
Fierro station, opposite office door; top of rail	6,672.3
Fierro, 1.16 miles north of, sec. 3, T. 17 S., R. 12 W., south slope of ridge between two branches of same road, 100 feet east of west road, 50 feet west of east road, 300 feet north of forks, in bowlder; aluminum tablet stamped "6931"	6,931.538

Hanover Junction east along Atchison, Topeka & Santa Fe Ry. to Santa Rita, thence west along highway to Hanover.

Cobre, in front of station sign; top of rail	6,084.1
T. 17 S., R. 12 W., in cornerstone of sections 26, 27, 34, and 35, 450 feet northeast of Santa Rita Church, 5 feet north of road; aluminum tablet stamped "6331"	6,331.289
Santa Rita, opposite entrance of station; rail joint	6,336.9

FORT BAYARD SPECIAL QUADRANGLE.

Bench marks near Fort Bayard.

	Feet.
Fort Bayard, on rise of ground 150 feet west of south end of driveway running back of officer's line, in stone monument; aluminum tablet (Astronomical station)	6,164.757
Fort Bayard, 0.75 mile south of, 200 feet west of Fort Bayard-Central road, 80 feet north of small creek, 12 feet east of angle in west fence; aluminum tablet stamped "6033"	6,033.117
Central triangulation signal, large stone at base of cairn; chisel mark	6,121.36
Fort Bayard, 1 mile southwest of, 300 feet west of large drain, 40 feet west of Fort Bayard-Silver City road where road enters valley, on stone; chisel mark	6,055.76
Fort Bayard, 1 mile southwest of, 200 feet east of Twin Sisters Creek, 40 feet west of Fort Bayard-Silver City road, on side of ridge in solid rock; aluminum tablet stamped "6060"	6,059.845
Twin Sisters Canyon, 200 feet west of, 10 feet north of old Pinos Altos-Fort Bayard road, in lane; aluminum tablet stamped "6290"	6,290.079
Fort Bayard, 0.75 mile north of, 200 feet north of road forks, 200 feet west of Cameron Creek, 10 feet west of road up west bank of creek, in large stone; aluminum tablet stamped "6162.6"	6,162.650
Fort Bayard, 2.5 miles north of, where lane turns west at road forks, 75 feet north of road forks, 30 feet west of gate, in base of large cedar stump; spike	6,416.00
Comanche Spring, in abutment of reservoir; aluminum tablet stamped "6807.6"	6,807.587
Fort Bayard, 3 miles north of, 400 feet north of where road turns off to Cornell's ranch, 50 feet west of Cameron Creek, 50 feet south of signboard, 2 feet west of road to Cornell ranch; aluminum tablet stamped "6389"	6,388.762
Forest nursery, 75 feet southwest of house, in large stone; aluminum tablet stamped "6473.5"	6,473.358

Boyles, Camp Vincent, Duncan, Mogollon, and Steeplerock Quadrangles.

GRANT AND SOCORRO COUNTIES.

The elevations in the following list were originally based on an aluminum tablet marked "1090" in the north front of the Maricopa County courthouse at Phœnix, Ariz., and the permanent bench marks are therefore stamped "PHNX". Recent leveling by the United States Geological Survey and preliminary elevations by the Coast and Geodetic Survey have enabled a connection to be made with mean sea datum at San Diego, Cal., and the elevations listed herein have been reduced to that datum by subtracting 1 foot from the previous values.

The leveling was done in 1902 and 1903 by Chester Irvine.

MOGOLLON QUADRANGLE.

Point 11.5 miles north of Steeplerock along highway via Pina Cienaga northwest 6.6 miles, then southwest to Big Lue ranch.

	Feet.
Steeplerock, 11.5 miles north of, 50 feet southeast of ranch house on stone; chiseled square	6,309.09
Pina Cienaga, 1.3 miles south of, summit of divide, west side of road; in root of oak tree; nail	6,517.45
Pina Cienaga, south end of, 100 feet north of northwest corner of Pitt ranch fence, 400 feet northwest of house and of forks of road; iron post stamped "6254 PHNX"	6,253.173
Pina Cienaga, 1 mile northwest of, at road crossing; summit of divide	6,306
Pina Cienaga, 1.3 miles northwest of, 50 feet northeast of forks of road at old ranch, in juniper stump; wire nail	6,266.24
Pina Cienaga, 3.6 miles northwest of, 10 feet south of road, at bend in mill creek; iron post stamped "5936 PHNX"	5,935.155
Pina Cienaga, 5.1 miles northwest of, west side of road, 200 feet southeast of frame house, on bowlder; chisel mark	5,804.24
Pina Cienaga, 6.6 miles northwest of, 40 feet north of road, on divide; iron post stamped "6199 PHNX"	6,197.781
Big Lue ranch, 9.8 miles northeast of, west side of road, foot of long hill, on bowlder; chiseled square	5,722.75
Big Lue ranch, 8.7 miles northeast of, 10 feet west of road, at junction of creeks; iron post stamped "5720 PHNX"	5,719.108
Big Lue ranch, 6.9 miles northeast of, west side of road, on divide, in stump; nail	6,136.57
Big Lue ranch, 5.2 miles northeast of, 100 feet north of old saw mill, 4 feet east of road, at junction of creeks; aluminum tablet stamped "5806 PHNX"	5,804.953
Big Lue ranch, 1.9 miles northeast of, west side of road, foot of hill, on bowlder; chiseled square	5,793.07
Welch ranch, 11.1 miles east of, 100 feet south of old cabin, 100 feet north of road, in sycamore tree; nail	4,250.01
Welch ranch, 12.6 miles east of, 150 feet north of river, 100 feet north of road, one-fourth mile west of deserted ranch, under small cliff; iron post stamped "4289 PHNX"	4,288.201
Mule Creek, 1 mile west of mouth of, 30 feet west of river, 20 feet west of road, in root of leaning sycamore tree; nail	4,318.36
Mule Creek, 0.3 mile east of, 200 feet south of San Francisco River, 30 feet south of road; aluminum tablet stamped "4347 PHNX"	4,346.575
Mule Creek, 2.3 miles east of, 100 feet north of river, 10 feet south of road, bowlder; chiseled square	4,388.26
Mule Creek, 3.3 miles east of, 100 feet north of river, 30 feet north of road; aluminum tablet stamped "4411 PHNX"	4,410.030
Mule Creek, 5 miles east of, 100 feet south of river on south side of road, bowlder; chiseled square	4,448.32
Big Dry Creek, 1.5 miles west of, 100 feet north of road, 150 feet north of river, under cliff, 40 feet high; iron post stamped "4483 PHNX"	4,482.041
Big Dry Creek, mouth of, 40 feet east of road, in root of sycamore tree; nail	4,514.61

	Feet.
Pleasanton, 2.3 miles south of, 200 feet east of river, 30 feet east of road, 60 feet west of cliff, detached bowlder; aluminum tablet stamped "4545 PHNX"	4,544.380
Pleasanton, 0.5 mile south of, 30 feet east of road, in root of cottonwood tree; nail	4,567.87
Pleasanton, 150 feet east of Goddard house, 10 feet west of road; iron post stamped "4635 PHNX"	4,634.063

Pleasanton north to Graham and return.

Graham, 0.3 mile south of, 200 feet southwest of Johnson house, 30 feet east of road; iron post stamped "5102 PHNX"	5,101.173
Graham, 4 miles south of, at intersection of Alma and Graham roads; aluminum tablet stamped "4746 PHNX"	4,745.168

Pleasanton south via Meader and Wilson ranches to Pina Cienaga.

Pleasanton, 3.2 miles south of, on divide between Pleasanton and Big Dry Creeks, 30 feet north of road; iron post stamped "5052 PHNX"	5,051.056
Wilson ranch, 1 mile northwest of, 60 feet north of old road, on flat, in root of lone tree; spike	4,978.70
Meader ranch, 30 feet northeast of house; aluminum tablet stamped "4884 PHNX"	4,882.680
Meader ranch, 3.2 miles south of, 40 feet north of road, in saddle; iron post stamped "5235 PHNX"	5,234.245
Meader ranch, 6.3 miles south of, on divide, 30 feet north of road; iron post stamped "5289 PHNX"	5,287.973
L. C. tank, 0.5 mile southwest of, 0.5 mile southwest of junction of Pina Cienaga-Graham road, 300 feet south of old rock house on hill; bronze tablet stamped "5148 PHNX"	5,146.876
L. C. tank, 2 miles southwest of, 140 feet east of road, in root of oak tree; nail	5,317.21
L. C. tank, 3 miles southwest of, 10 feet east of forks of road, at monument on flat, on stone; chiseled square	5,431.66
High Lonesome ranch, southeast corner of house; aluminum tablet stamped "5513 PHNX"	5,512.590
High Lonesome ranch, 1 mile south of, 300 feet south of gate, bowlder; chisel mark	5,545.35
High Lonesome ranch, 3.6 miles southwest of, east bank of Cienaga Creek, 50 feet west of road; aluminum tablet stamped "5337 PHNX"	5,336.145
Wilson ranch in Mill Creek, 100 feet north of house, in stump; nail	5,419.43
Wilson ranch, 1.9 miles south of, 50 feet south of road, on divide; bronze tablet stamped "5747 PHNX"	5,746.455
Wilson ranch, 3.5 miles southeast of, 40 feet south of fence corner, 3 feet west of road, on bowlder; chiseled square	5,909.44
Pina Cienaga, 2.5 miles north of, 20 feet east of road, on stone; chisel mark	6,352.24
Pina Cienaga, 2 miles north of junction of Graham-Silver City roads; bronze tablet stamped "6365 PHNX"	6,364.590

Alexander ranch east along highway via Raines ranch to Howard Cienaga, thence northwest along stage road via White House to L. C. tank.

	Feet.
Oldham ranch, 300 feet south of, 30 feet north of gate in yard; chisel mark	5,727.65
Oldham ranch, 1.6 miles east of, at foot of big hill, and at forks of road, on bowlder; chisel mark	5,607.60
beside monument of stone 3 feet high; aluminum tablet stamped	
Oldham ranch, 2.6 miles east of, 10 feet north of road on ridge, "6107 PHNX"	6,106.240
Oldham ranch, 4.9 miles northeast of, 20 feet east of road on summit of divide; aluminum tablet stamped "6411 PHNX"	6,410.387
Raines ranch, 0.3 mile east of, on small hill in basin, 300 feet north of road, black stone monument; aluminum tablet stamped "5914 PHNX"	5,913.454
Raines ranch, 2.5 miles east of, hillside 50 feet east of road, on bowlder; chisel mark	6,111.13
Raines ranch, 5 miles east of, 10 feet east of road, on summit of ridge; iron post stamped "6310 PHNX"	6,309.597
Raines ranch, 9 miles east of, 30 feet west of road at point where it begins steep descent, bowlder; chiseled square	6,184.83
White House, about 3 miles south of, 20 feet south of road, at rocky, point, 0.25 mile east of foot of big hill; bronze tablet stamped "5000 PHNX"	4,999.613
Cliff, 3 miles northwest of, Howard Cienaga, junction of Graham and Blue Creek Roads; iron post stamped "4596 PHNX"	4,595.330
Cliff, 6 miles northwest of, 30 feet north of road on rocky point alongside stone monument, on embedded bowlder; chiseled square	4,754.33
White House, 1 mile east of, 30 feet south of fence corner, on north side of road, in root of juniper tree; nail	4,662.20
White House, 100 feet northwest of, at fence corner, on top of embedded bowlder; bronze tablet stamped "4716 PHNX"	4,714.661
White House, 4 miles west of, 40 feet west of road, bowlder beside stone monument; chiseled square	4,882.15
White House, 6.5 miles west of, 12 feet south of road, at rocky point, in top of bowlder; aluminum tablet stamped "4981 PHNX"	4,980.276

At Howard Ranch.

Howard ranch, 2 miles north of, end of concrete ridge, 40 feet east of road, east side of Gila River; bronze tablet stamped "4700 PHNX 1903"	4,698.919

Howard Cienaga southeast to Cliff, thence north and west up Gila River and Mogollon Creek via Box N and Rice ranches and L. C. pasture to Graham road, 3 miles northwest of L. C. tank.

Bell ranch, 100 yards south of, on edge of mesa, at forks of road; aluminum tablet stamped "4626 PHNX"	4,625.319
Doyle farm, 60 feet west of house, in root of tree; nail	4,577.18
Winkler ranch, 1,000 feet west of, 40 feet northwest of fence corner; 10 feet north of road; aluminum tablet stamped "4611 PHNX"	4,610.433
Mogollon Creek, mouth of, 5 feet east of Russell cabin, on north bank; aluminum tablet stamped "4650 PHNX"	4,649.455

	Feet.
Russell ranch, 3 miles west of, 20 feet north of road in Mogollon Creek, alongside stone monument; aluminum tablet stamped "4806 PHNX"	4,805.541
Shelly ranch, 200 feet north of house, in stump; nail	5,000.28
Box N ranch, 900 feet south of, south bank of Mogollon Creek, 40 feet above creek bed, 30 feet east of road; aluminum tablet stamped "5099 PHNX"	5,098.625
Box N ranch, 3 miles west of, 30 feet north of road, beside stone monument; aluminum tablet stamped "5722 PHNX"	5,721.440
Rice ranch, 1.8 miles east of, at northwest corner of Bell's pasture fence, 5 feet north of junction of roads; aluminum tablet stamped "6041 PHNX"	6,040.382
Rice ranch, 1.4 miles west of, at junction of roads, 300 feet east of gate to Lyon & Campbell's pasture; aluminum tablet marked "5847 PHNX"	5,846.531
Rice ranch, 4.4 miles west of, south side of road, at west gate to Lyon & Campbell's pasture; aluminum tablet stamped "5697 PHNX"	5,696.287

BOYLES QUADRANGLE.

Big Lue ranch along highways up San Francisco River to Pleasanton.

Big Lue ranch, 0.5 mile northeast of, on divide, at intersection of roads; iron post stamped "6101 PHNX"	6,099.641
Welch ranch, 8.3 miles north of, 80 feet south of river, 20 feet east of road, in root of cottonwood tree; wire nail	4,182.43
Welch ranch, 9.1 miles northeast of, 200 feet south of river, 40 feet south of road, 3 feet south of large bowlder under cliff; iron post stamped "4213 PHNX"	4,212.078

STEEPLEROCK QUADRANGLE.

Point 3.3 miles southwest of Steeplerock northeast along highway via Steeplerock and Alexander ranch.

Steeplerock, 3.3 miles southwest of, 550 feet southwest of Imperial mine, 12 feet south of ruins of rock house, 30 feet east of road, 10 feet above creek bed; aluminum tablet stamped "4714 PHNX"	4,712.870
Steeplerock, 2 miles south of, third post south of gate to Powell cabin, at junction of drains; spike driven close to ground	4,837.70
Steeplerock, northwest corner of store building; aluminum tablet stamped "5133 PHNX"	5,132.314
Steeplerock, 0.3 mile east of, 20 feet east of stamp mill, in southwest corner of crown plate of air shaft; spike	5,238.28
Steeplerock, 2.2 miles north of, foot of round-topped mountain, west bank of creek, west of and 3 feet above wagon road; aluminum tablet stamped "5439 PHNX"	5,438.311
Steeplerock, 3.9 miles north of, summit of Cherry Mountains, west side of road, on rock; chiseled square	5,876.11
Steeplerock, 4.3 miles north of, junction of drains, bowlder at angle of road; chiseled square	5,682.49
Steeplerock, 5.1 miles north of, southeast of ruins of old house, 20 feet south of road; iron post stamped "5787 PHNX"	5,786.051

	Feet.
Steeplerock, 6.1 miles north of, 1.5 miles south of Alexander ranch, summit of Bluewater Mountains, at road crossing, stone 4 feet west of road; chiseled square	6,184.38
Steeplerock, 7.4 miles north of, 900 feet south of Alexander ranch house, at intersection of wagon roads; iron post stamped "5868 PHNX"	5,867.474
Steeplerock, 11 miles north of, 0.8 mile east of Deer Lick Cienaga, 500 feet west of forks of road, on summit of ridge; iron post stamped "6339 PHNX"	6,338.388

Mangas Valley west along highway to Duncan.

Foraker ranch, 3 miles south of, 30 feet west of road, on divide of Burro Mountains; bronze tablet stamped "6350 PHNX 1902"	6,350.066
Knox ranch, 30 feet south of fence corner, on bowlder; chiseled square	5,946.384
Knox ranch, 2 miles south of, 100 feet east of road at rocky point; bronze tablet marked "5608 PHNX 1902"	5,607.884
Brock ranch, 2.8 miles west of, 40 feet east of junction of Gila River and Duncan roads; aluminum tablet stamped "5376 PHNX 1902"	5,375.812
Brock ranch, 5.5 miles west of, 5 feet north of road crossing; bronze tablet stamped "5006 PHNX 1902"	5,005.804
Brock ranch, 8.8 miles west of, 10 feet west of road, at trail crossing; aluminum tablet stamped "4698 PHNX 1902"	4,697.950
Brock ranch, 12.3 miles west of, at road crossing; iron post stamped "4424 PHNX 1902"	4,423.795
Brock ranch, 15.2 miles west of, junction of old and new Silver City-Duncan roads; iron post stamped "4382 PHNX"	4,381.566
24 ranch, 7 miles east of, on south bank of drain, 20 feet south of road; iron post stamped "4149 PHNX"	4,148.284
24 ranch, 4.2 miles east of, 0.3 mile south of two black buttes, on summit of divide, 10 feet south of road; iron post stamped "4130 PHNX"	4,129.300
24 ranch, 2.5 miles east of, at junction of Lordsburg and Silver City roads, in drain; iron post stamped "4011 PHNX"	4,010.934
Duncan, 12 miles east of, 40 feet southwest of Catholic Church, 15 feet east of road; iron post stamped "3800 PHNX 1902"	3,799.774
Wilson ranch, 200 yards south of, end of gravel ridge, 30 feet east of road; iron post stamped "3765 PHNX"	3,764.465

Howard Cienaga southeast to Cliff, thence northeast up Gila River.

Cliff, 1.5 miles north of, 30 feet east of road; at Warm Springs, in root of willow tree; nail	4,540.13
Cliff, 0.3 mile north of post office, 30 feet west of forks of road, beside stone monument, on top of embedded bowlder; bronze tablet stamped "4522 PHNX"	4,520.637
Bell ranch, 100 yards south of, on edge of mesa, at forks of road; aluminum tablet stamped "4626 PHNX"	4,625.319

Cliff southeast along stage road toward Silver City.

Gila Hotel, 400 feet south of, at gate, west side of road; iron post stamped "4470 PHNX"	4,469.043
Gila Hotel, 1 mile south of, at forks of road, bowlder; chiseled square	4,458.00

	Feet.
Gila Hotel, 2.5 miles east of, forks of Red Barn and Cliff roads, 15 feet north of road, on side of ridge; iron post stamped "4554 PHNX"	4,453.089
Jones ranch, 600 feet north of house, bowlder; chisel mark	4,692.03
Metcalf ranch, 3 miles north of, on summit of divide, 15 feet west of road; iron post stamped "4901 PHNX"	4,900.038
Menton house, 1,000 feet northwest of, 100 feet south of road; iron post stamped "4771 PHNX"	4,762.093

CAMP VINCENT QUADRANGLE.

Sapello northwest to Gila Forks, thence down Gila River to Mogollon Creek.

Sapello Creek, north bank of, 40 feet south of lower G. O. S. ranch; iron post stamped "5834 PHNX"	5,832.934
Brannen ranch, southeast corner of house, south side of Sapello Creek; iron post stamped "5993 PHNX"	5,991.884
Hill ranch, on Sapello Creek, 300 yards north of, 10 feet east of road to Hot Springs; iron post stamped "6126 PHNX 1903"	6,124.761
Hill ranch, 3 miles north of, 10 feet east of road, near saddle on ridge, beside stone monument; aluminum tablet stamped "7487 PHNX 1903"	7,486.109
Hill ranch, 6 miles northwest of, 10 feet south of road, in saddle of ridge; bronze tablet stamped "7382 PHNX 1903"	7,380.693
Hill ranch, 10 miles north of, forks of wagon road, north side of saddle; aluminum tablet stamped "7390 PHNX 1903"	7,389.015
Gila Hot Springs, 2.5 miles south of, 15 feet east of road on round knob, 60 feet east of section corner marked 111 on east, 1111 on west; aluminum tablet stamped "6484 PHNX 1903"	6,482.469
Gila River, forks of, 50 feet west of road on hillside, south bank of east fork; aluminum tablet stamped "5567 PHNX 1903"	5,565.365
Gila Forks, 3.25 miles south of, yellow sandstone ledge on west bank of Gila River, opposite deserted ranch house; aluminum tablet stamped "5466 PHNX 1903"	5,464.428
Gila Forks, 6.58 miles south of, projection of ledge 30 feet south of road, west side of Gila River; aluminum tablet stamped "5386 PHNX 1903"	5,384.578
Gila Forks, 9.39 miles south of, projection of ledge 40 feet north of corral, 50 feet south of road, on east bank of Gila River; bronze tablet stamped "5312 PHNX 1903"	5,310.746
Gila Forks, 12.62 miles south of, 250 feet east of log cabin on flat, east side of Gila River; aluminum tablet stamped "5225 PHNX 1903"	5,223.784
Sapello Creek, 1 mile west of, detached bowlder at foot of hill, 30 feet west of road, west side of Gila River; aluminum tablet stamped "5149 PHNX 1903"	5,147.981
Sapello Creek, 4 miles west of, 10 feet south of group of detached bowlders, 40 feet east of road on east side of Gila River; bronze tablet stamped "5086 PHNX 1903"	5,084.609
Sapello Creek, 8 miles south of, 40 feet east of road, east side of Gila River, large white sandstone bowlder; bronze tablet stamped "4991 PHNX 1903"	4,989.547
Sapello Creek, 11 miles south of, large sandstone bowlder at foot of cliff, north side of road, west side of Gila River; bronze tablet stamped "4914 PHNX 1903"	4,912.745

	Feet.
Sapello Creek, 14 miles south of, bench 4 feet above ground, on stone bluff, 30 feet north of road, west side of Gila River; bronze tablet stamped "4835 PHNX 1903"	4,833.546
Turkey Creek, 0.25 mile south of, 40 feet west of road, near rock bluff, west side of Gila River; bronze tablet stamped "4770 PHNX 1903"	4,768.875

Chiricahua and San Simon Quadrangles.

GRANT COUNTY.

The elevations in the following list are based upon the precise level line along the Southern Pacific Railroad. For additional elevations on these quadrangles refer to level lists in Arizona.

The leveling was done in 1907 by T. A. Green.

SAN SIMON QUADRANGLE.

Cienaga north to Paramores ranch.

	Feet.
Cienaga, 250 feet west of, in southeast corner of pasture lot of J. A. Chenoweth's ranch, just northwest of crossroads, in large rock; aluminum tablet stamped "3911 1907"	3,921.732

Cienaga south 5 miles.

Rodeo, 13 miles north of, Ed Hill ranch, 0.54 mile north of, 10 feet west of road; iron post stamped "3935 1907"	3,945.700

CHIRICAHUA QUADRANGLE.

Rodeo north 9.7 miles to bench mark 5 miles south of Cienaga.

Rodeo, 200 feet southeast of station, 230 feet south of track, west side of store and post office kept by A. D. Wallace; iron post stamped "4115 1907"	4,126.201
Rodeo, 3.77 miles north of, in southeast corner of fence around windmill and water tank; iron post stamped "4052 1907"	4,063.402
Rodeo, 6.13 miles north of, 40 feet west of road, midway between two trees; iron post stamped "4042 1907"	4,052.456
Cienaga, 5 miles south of, east side of road, 50 feet west of house occupied by G. W. Shipman, 8 feet west of fence; iron post stamped "4004 1907"	4,014.964

Alamogordo, Avis, Gypsum Hills, Las Cruces, and Orogrande Quadrangles.

DONA ANA AND OTERO COUNTIES.

The elevations in the following list were determined by primary leveling extended from El Paso, Tex., based on an elevation determined by precise leveling. The elevations on line from a point near Newman ranch to Anthony, in the Orogrande and Las Cruces quadrangles, part of a closed circuit, are adjusted. The line along the El Paso & Southwestern Railroad to Alamogordo and along high-

way 10 miles east of Alamogordo in the Alamogordo, Orogrande, and Gypsum Hills quadrangles is a single unchecked line. A circuit was extended from the latter point to Pinon, but on account of an excessive closure error it has not been adjusted. Additional elevations in the Las Cruces quadrangle are given in a list for precise leveling.

The leveling in the Orogrande and Las Cruces quadrangles was done in 1907 by Fred McLaughlin, and that in the Alamagordo, Avis, Orogrande, and Gypsum Hills quadrangles in 1909 by K. W. Trimble.

OROGRANDE QUADRANGLE.

State line northeast along El Paso & Southwestern R. R. to point 3.8 miles northeast of Turquoise (part of a single unchecked line from El Paso, Tex., via Alamogordo to point 10 miles southeast of Alamogordo).

	Feet.
Texas-New Mexico boundary line; top of rail opposite line post	3,999.7
Newman, in south side of concrete base of water tank; chisel mark, marked "3997.95 B. M."	3,997.95
Newman, 2 miles northeast of, at milepost 21, 50 feet west of railroad; iron post stamped "3981"	3,980.733
Hueco, 0.8 mile southwest of, at milepost 24, 50 feet west of railroad; iron post stamped "4053"	4,052.642
Hueco, opposite stock pens; top of rail	4,072.66
Hueco, 2.2 miles northeast of, at milepost 27, 50 feet west of railroad; iron post stamped "4101"	4,101.109
Alvarado, opposite signboard; top of rail	4,100.7
Alvarado, 0.5 mile northeast of, at milepost 30, 50 feet west of railroad; iron post stamped "4099"	4,098.963
Desert, 2.5 miles southwest of, at milepost 33, 50 feet west of railroad; iron post stamped "4078"	4,078.014
Desert, opposite signboard "Desert;" top of rail	4,085.2
Desert, 0.7 mile northeast of, at milepost 36, 50 feet west of railroad; iron post stamped "4077"	4,077.113
Desert, 3.7 miles northeast of, at milepost 39, 50 feet west of railroad; iron post stamped "4085"	4,085.002
Elwood, 0.5 mile southwest of, at milepost 42, 50 feet west of railroad; iron post stamped "4089"	4,088.641
Orogrande, 3.2 miles southwest of, at milepost 45, 50 feet west of railroad; iron post stamped "4104"	4,104.003
Orogrande, in front of station; top of rail	4,179.0
Orogrande, 200 feet west of station; iron post stamped "4180"	4,179.557
Orogrande, 2.8 miles northeast of, at milepost 51, 50 feet west of railroad; iron post stamped "4173"	4,173.322
Orogrande, 5.8 miles northeast of, at milepost 54, 50 feet west of railroad; iron post stamped "4119"	4,119.368
Turquoise, 2.8 miles northeast of, at milepost 57, 50 feet west of railroad; iron post stamped "4058"	4,057.965

Newman ranch northwest along highway to Anthony Pass.

Newman ranch, 1.8 miles west of, 15 feet west of road forks; iron post stamped "4092"	4,103.237
Newman ranch, 4.8 miles west of, 10 feet south of road; iron post stamped "4301"	4,313.153

LAS CRUCES QUADRANGLE.

Anthony Gap west along highways to La Tuna (Anthony post office).

	Feet.
Anthony, 3.7 miles east of, 10 feet north of road, 30 feet north of creek; iron post stamped "4155"	4,166.603
La Tuna (Anthony post office), 33 feet west of track, 4 feet north of Texas-New Mexico line; iron post stamped "3780"	3,791.743

GYPSUM HILLS QUADRANGLE.

Point 3.8 miles northeast of Turquoise northeast along El Paso & Southwestern R. R. to point 4 miles northeast of Escondido (part of a single unchecked line from El Paso, Tex., via Alamogordo to point 10 miles southeast of Alamogordo).

Turquoise, 5.8 miles northeast of, at milepost 60, 50 feet west of El Paso & Southwestern R. R.; iron post stamped "4018"	4,017.504
Escondido, 2 miles southwest of, at milepost 63, 50 feet west of railroad; iron post stamped "4034"	4,033.979
Escondido, 1 mile northeast of, at milepost 66, 50 feet west of railroad; iron post stamped "4020"	4,019.788
Escondido, 4 miles northeast of, at milepost 69, 50 feet west of railroad; iron post stamped "4004"	4,004.193

ALAMOGORDO QUADRANGLE.

Point 4 miles northeast of Escondido northeast along El Paso & Southwestern R. R. to Alamogordo (part of a single unchecked line from El Paso, Tex., via Alamogordo to point 10 miles southeast of Alamogordo).

Dog Canyon, 3.2 miles southwest of, at milepost 72, 50 feet west of railroad; iron post stamped "4004"	4,004.118
Dog Canyon, in front of station; top of rail	4,035.6
Dog Canyon, 150 feet west of station; iron post stamped "4034"	4,033.588
Dog Canyon, 1.7 miles northeast of, at milepost 78, 50 feet west of railroad; iron post stamped "4072"	4,072.179
Omlee, opposite signboard; top of rail	4,184.8
Omlee, 50 feet west of signboard; iron post stamped "4183"	4,182.926
Alamogordo, 2 miles southwest of, at milepost 84, 50 feet west of railroad; iron post stamped "4295"	4,295.424
Alamogordo, in front of station; top of rail	4,333.9
Alamogordo, courthouse, south end of lower stone step of west approach to south entrance; aluminum tablet stamped "4342"	4,341.810

Near Alamogordo.

Alamogordo, 1 mile north of, on west end of top stone step of south approach to east entrance of basement of Institute for the Blind; chisel mark	4,363.61

Alamogordo southeast via Woods and Atkinson ranches to Alamo lumber camp on Penasco Creek (single, unchecked line).

Alamogordo, 3.5 miles southeast of, on Alamo Canyon road, 50 feet southeast of road fork, on limestone rock; chisel mark, marked "4744.78"	4,744.78
Alamogordo, 3.7 miles southeast of, at mouth of Alamo Canyon, in north end of east concrete abutment of Alamo Creek conduit; aluminum tablet stamped "4805"	4,804.522

	Feet.
Alamogordo, 4.7 miles east of, 20 feet south of Alamo Canyon trail, on limestone ledge; chisel mark, marked "5008 B. M."	5,008.02
Alamogordo, 5.6 miles east of, 50 feet east of junction of Alamo and Cabellero canyons, on limestone ledge; chisel mark, marked "5200.73 B. M."	5,200.73
Alamogordo, 7 miles east of, 10 feet south of Alamo Creek, in Alamo Canyon, in limestone ledge; aluminum tablet stamped "5592"	5,591.735
Alamogordo, 9 miles east of, 3 feet east of Alamo trail at junction of Gordon Gulch and Alamo Canyon, in limestone ledge; chisel mark, marked "6210.36 B. M."	6,210.36
Alamogordo, 10.2 miles east of, 100 feet north of Woods ranch house, in sandstone rock; aluminum tablet stamped "7050"	7,049.680
Alamogordo, 11.1 miles east of, south side of Woods-Atkinson trail, in root of pine tree; nail, marked "7397.8 B. M."	7,397.82
Atkinson ranch, 0.5 mile west of, on Woods-Atkinson trail at summit of Sacramento Mountain, in root of pine tree; nail, marked "8995.56"	8,995.56
Alamo Lumber Co. camp on Penasco Creek, 75 feet southeast of stables, in limestone ledge; aluminum tablet stamped "8786"	8,786.099

Alamo Lumber Co. camp southeast via Rice Canyon, Sacramento River road, and Carissa ranger station to Stephens Lake.

NOTE.—Part of this circuit has an error of 1.9 feet, which has not been adjusted.

Rice Canyon, 1 mile west of mouth, on Rice Canyon road, 15 feet north of road fork, on sandstone rock; chisel mark, marked "8845.65 B. M."	8,845.65
Alamo Lumber Co. camp, 4 miles southeast of, on Sacramento River road at summit of mountain, 20 feet south of road fork, in limestone rock; aluminum tablet stamped "9498"	9,497.523
Verdon ranch house, 3.2 miles northwest of, 10 feet north of Sacramento River road, in root of aspen tree; nail, marked "8891.8 B. M."	8,891.84
Verdon ranch house, 0.4 mile west of, 60 feet northeast of junction of Sacramento River and Wills Canyon roads, in limestone ledge; aluminum tablet stamped "8432"	8,431.749
Bishop ranch house, 1.1 miles northwest of, 10 feet south of Sacramento River road, in sandstone rock; chisel mark, marked "8089.3 B. M."	8,089.31
Bishop ranch house, 50 feet west of, 10 feet north of Sacramento River road, in limestone ledge; aluminum tablet stamped "7934"	7,933.745
Spiller ranch house, 0.2 mile east of, 15 feet north of Sacramento River road, in sandstone rock; aluminum tablet stamped "7426"	7,426.149
O. M. Lee ranch house, 0.5 mile east of, 100 feet west of mouth of Graveyard Canyon, 20 feet north of Sacramento River road, in sandstone rock; aluminum tablet stamped "7071"	7,071.138
Key ranch house, 600 feet northeast of, 30 feet north of Sacramento River road, in limestone ledge; chisel mark, marked "6816.45 B. M."	6,816.45
Carissa ranger station, 200 feet west of, 25 feet south of Sacramento River bed, in limestone ledge; aluminum tablet stamped "6685"	6,685.268
Fleming ranch house, 0.2 mile east of, 10 feet north of Sacramento River bed, in root of blazed pine tree; nail, marked "6578 B. M."	6,577.85

	Feet.
Fleming ranch house, 2.5 miles east of, 10 feet south of Sacramento River bed, in limestone ledge; aluminum tablet stamped "6359"	6,358.901
Fleming ranch house, 4.6 miles east of, on south side of Sacramento River road, 5 feet south of Sacramento River bed, in limestone; chisel mark, marked "6164.3 B. M."	6,164.25
Daugherty ranch house, 0.6 mile north of, 100 feet north of Sacramento River road and 150 feet north of Daugherty's tank, in limestone ledge; aluminum tablet stamped "6039"	6,038.909
Stephens Lake, 3.2 miles west of, 25 feet north of Surveyor Canyon road, in sandstone; chisel mark, marked "6194.2 B. M."	6,194.16
Stephens Lake, 2.1 miles west of, 70 feet south of Surveyor Canyon road, 25 feet south of Surveyor Canyon Creek, in limestone ledge; aluminum tablet stamped "6352"	6,352.108
Stephens Lake, 0.8 mile west of, 60 feet south of Surveyor Canyon road, in root of blazed pine tree; nail, marked "6518 O. B. M."	6,518.05

Weed west along highway to Alamo Lumber Co. camp on Penasco Creek.

NOTE.—Part of the circuit has an error of 1.9 feet, which has not been adjusted.

Weed, 4.2 miles west of, 600 feet northwest of junction of Aqua Chiquita and Cloudcroft roads, 20 feet east of Cloudcroft road, in limestone ledge; aluminum tablet stamped "7391"	7,390.541
Weed, 6.6 miles northwest of, 15 feet north of Weed-Cloudcroft road, on sandstone rock; chisel mark, marked "7857.3 B. M."	7,857.30
Weed, 7.2 miles northwest of, summit between Aqua Chiquita and Bear canyons, 50 feet west of Weed-Cloudcroft road, in limestone ledge; aluminum tablet stamped "8162"	8,161.880
Weem's ranch house, 200 feet north of Bear Canyon, 15 feet east of Weed-Cloudcroft road, in root of blazed oak tree; nail, marked "7623 B. M."	7,622.99
Weed, 9.2 miles northwest of, top of divide between Bear Canyon and Penasco Creek, 25 feet east of Weed-Cloudcroft road; chisel mark on limestone rock; blazed pine tree, marked "7868.3"	7,868.313
Cox Canyon, 0.2 mile west of mouth, 5 feet north of Penasco Creek road, in limestone ledge; aluminum tablet stamped "7135"	7,135.286
Alamo Lumber Co. camp, 8.1 miles east of, 15 feet north of Panasco Creek road, in limestone ledge; aluminum tablet stamped "7639"	7,638.979
Alamo Lumber Co. camp, 8.1 miles east of, 15 feet north of Penasco Creek road, in root of blazed pine tree; nail, marked "7786 B. M."	7,786.02
Alamo Lumber Co. camp, 3.9 miles east of, 20 feet north of Penasco Creek road, in limestone ledge; aluminum tablet stamped "8104"	8,103.534
Alamo Lumber Co. camp, on Penasco Creek, 75 feet southeast of stables, in limestone ledge; aluminum tablet stamped "8786"	8,788.043
Elevation from northwest	8,786.099
Closure error	1.944

AVIS QUADRANGLE.

Stephens Lake northeast along highway to Pinon, thence northwest to Weed.

Worthington ranch house, 0.3 mile southeast of, 50 feet south of Sacramento-Pinon road, in limestone ledge; aluminum tablet stamped "6520"	6,519.707

	Feet.
McElrath ranch, 0.5 mile west of, 10 feet south of Sacramento-Pinon road, in root of blazed pinon tree; nail, marked "6471.7 B. M."	6,471.74
McElrath ranch house, 1 mile east of, 30 feet south of Sacramento-Pinon road, in root of blazed pinon tree; nail, marked "6273.1 B. M."	6,273.11
Wright's ranch house, 300 feet west of, 50 feet south of Sacramento-Pinon road, in limestone rock; aluminum tablet stamped "6164"	6,163.944
Pinon, 0.9 mile west of, 25 feet north of Sacramento-Pinon road, in limestone rock; chisel mark, marked "6031.6 B. M."	6,031.57
Pinon, 1.4 miles north of, 50 feet east of Pinon-Weed road, in limestone rock; aluminum tablet stamped "6102"	6,101.856
Pinon, 3.6 miles north of, 5 feet west of Pinon-Weed road, on limestone ledge; chisel mark, marked "6460.5 B. M."	6,460.48
Pinon, 4.6 miles north of, 10 feet south of Pinon-Weed road, in limestone rock; aluminum tablet stamped "6664"	6,664.157
Avis, 1.2 miles east of, 15 feet north of Pinon-Weed road, on limestone rock; chisel mark, marked "6684 B. M."	6,684.07
Avis, 0.2 mile east of, 40 feet north of Pinon-Weed road, in limestone ledge; aluminum tablet stamped "6767"	6,766.697
Avis, 1.3 miles northwest of, 20 feet south of Pinon-Weed road, in limestone ledge; aluminum tablet stamped "6937"	6,937.085
Avis, 2.9 miles northwest of, 10 feet east of Pinon-Weed road, on limestone ledge; chisel mark, marked "6870.3 B. M."	6,870.31
Avis, 3.6 miles northwest of, 20 feet west of Blue Water Canyon road fork, on limestone rock; chisel mark, marked "6814.5 B. M."	6,814.46
Avis, 5.5 miles northwest of, 40 feet south of Pinon-Weed road, at top of divide between Blue Water and Perk canyons, in limestone ledge; aluminum tablet stamped "7290"	7,290.186
Weed, 3.6 miles southeast of, 30 feet west of Pinon-Weed road, in root of oak tree; nail, marked "6980.1 B. M."	6,980.10
Weed, 300 feet northeast of post office, 30 feet east of road, in limestone ledge; aluminum tablet stamped "7043"	7,042.601

Magdalena, San Marcial, and Socorro quadrangles.

SOCORRO COUNTY.

The elevations in this list are determined by primary leveling connected with the precise-level line over the Atchison, Topeka & Santa Fe Railway, which crosses the San Marcial and Socorro quadrangles.

Leveling in all three quadrangles was done by Chester Irvine in 1904. Additional leveling was done in the Magdalena quadrangle by F. A. Nussle and in the San Marcial quadrangle by B. D. Stewart in 1905.

SAN MARCIAL QUADRANGLE.

Near Socorro.

	Feet.
Luis Lopez, 4.5 miles south of Socorro, at southwest corner of church; iron post stamped "4575-SOCR-1904"	4,580.227

SOCORRO QUADRANGLE.

Socorro north over Atchison, Topeka & Santa Fe Ry. to Lemitar.

	Feet.
Socorro, 2 miles south of, 40 feet southwest of railroad crossing; iron post stamped "4568–SOCR–1904"	4,573.252
Socorro, in front of station; top of rail	4,587.4
Socorro, 3 miles north of, 90 feet east of Escondido Church; iron post stamped "4624–SOCR–1904"	4,629.264
Lemitar, 50 feet southeast of signboard at station; iron post stamped "4618–SOCR–1904"	4,623.677
Lemitar, 3 miles north of, 40 feet east of railroad crossing; iron post stamped "4636–SOCR–1904"	4,641.046

Luis Lopez northwest along road to Socorro Canyon.

Luis Lopez, 1.6 miles northwest of, 5 feet from road, on end of ridge, north side of drain; aluminum tablet stamped "4820–SOCR"	4,825.414

Socorro south and west via Magdalena Branch.

Socorro, 3.5 miles southwest of, 50 feet west of road crossing, near dam in arroyo; iron post stamped "4919–SOCR–1904"	4,924.766
Socorro, 5 miles southwest of, at southeast corner of old section house; iron post stamped "5159–SOCR–1904"	5,164.423
Socorro, 7.8 miles southwest of, 30 feet north of railroad, on flat bench; iron post stamped "5497–SOCR–1904"	5,502.523

Socorro north and west along road toward Snake Ranch.

Socorro, in northwest corner of courthouse; aluminum tablet stamped "4610–SOCR–1904"	4,615.479
New Mexico School of Mines, southeast corner of building; aluminum tablet stamped "4616–SOCR–1904"	4,621.534
New Mexico School of Mines, 3.5 miles north of, 5 feet south of road, south bank of Nogah Canyon; iron post stamped "4806–SOCR–1904"	4,810.527
New Mexico School of Mines, 6 miles northwest of, 10 feet south of road on end of ridge; iron post stamped "5115–SOCR–1904"	5,120.435

Lemitar west along road toward Polvadera Mountain.

Lemitar, 3 miles west of, 20 feet north of road, 0.8 mile east of foot of mountain; iron post stamped "5101–SOCR–1904"	5,106.329

Escondido east to Ojo de la Parida, thence north 9 miles, thence west to Alamillo.

Publito, 2 miles east of, 10 feet north of wagon road, 150 feet north of drain; iron post stamped "4878–SOCR–1904"	4,883.376
Ojo de la Parida ranch, 1.5 miles west of, 120 feet east of road forks, end of high ridge; iron post stamped "5188–SOCR–1904"	5,193.337
Ojo de la Parida, 2.5 miles north of, 50 feet west of road, by mesquite tree on flat; iron post stamped "5118–SOCR–1904"	5,123.564
Ojo de la Parida, 6 miles northeast of, 10 feet east of ranch, 0.5 mile east of middle one of three hills on flat; iron post stamped "5116–SOCR–1904"	5,121.513

	Feet.
Ojo de la Parida, 8.5 miles northwest of, 40 feet north of trail, in saddle, south foot of rock butte; aluminum tablet stamped "5184–SOCR–1904"	5,189.514
Alamillo, 3.5 miles northeast of, alongside blazed cedar tree, on sand mesa; aluminum tablet stamped "4972–SOCR–1904"	4,977.284

Polvadera northwest to San Lorénzo Arroyo.

Polvadera, 2.2 miles northwest of, 20 feet south of point where road crosses divide to San Lorenzo Arroyo; iron post stamped "4926–SOCR–1905"	4,931.127

Jaral Largo east to Ojo dé las Canas, thence north to Ojo de la Parida.

Jaral Largo, 0.7 mile northeast of, 150 feet north of Arroyo de las Canas at road crossing of arroyo, about 17 feet above arroyo bed, on point of hill; iron post stamped "4650–SOCR–1905"	4,655.400
Ojo de las Canas, 150 feet northwest of spring, 5 feet east of small rock house, in large limestone bowlder; aluminum tablet stamped "5050–SOCR–1905"	5,055.970
Ojo de las Canas, 4.8 miles north of, 100 feet northeast of township corner T. 2 S., R. 1 E., in rock outcrop; aluminum tablet stamped "5190–SOCR–1905"	5,195.955

MAGDALENA QUADRANGLE.

Magdalena Branch of Atchison, Topeka & Santa Fe Railway to Snake ranch.

Cactus Flat ranch, 2.5 miles west of, 40 feet south of railroad, west foot of small white hill; iron post stamped "5762–SOCR–1904"	5,767.597
Snake ranch, 800 feet west of, 10 feet south of road from ranch to Magdalena; iron post stamped "5747–SOCR–1904"	5,752.611

Socorro north and west to Snake ranch.

Snake ranch, 1.6 miles northeast of, 50 feet north of road, summit of high ridge, north foot of Strawberry Peak; aluminum tablet stamped "5921–SOCR–1904"	5,925.851

Up San Lorenzo Arroyo to San Lorenzo Spring.

San Lorenzo Spring, 100 feet west of, 10 feet above bottom of wash, 6.1 feet north of northwest corner of adobe ruin; iron post stamped "5438–SOCR–1905"	5,442.817

San Lorenzo Spring south along road to Snake ranch.

San Lorenzo Spring, 3.7 miles southwest of, 20 feet east of road, on summit of low ridge; aluminum tablet stamped "5905–SOCR–1905"	5,910.395
Snake ranch, 4.4 miles west of north of, 10 feet east of road, on top of low ridge; iron post stamped "6067–SOCR–1905"	6,071.818

Forks of road 1 mile south of San Lorenzo Spring south toward Snake ranch.

San Lorenzo Spring, 4 miles southwest of, 20 feet south of road, top of main divide, 500 feet south of southeast corner of Sander's fence; iron post stamped "5949–SOCR–1905"	5,954.097

Cactus Flat ranch northwest along railroad to Magdalena, thence southeast via smelter railroad and wagon road to Kelly.

	Feet.
Cactus Flat ranch, 2.5 miles west of, 40 feet south of railroad, about 300 feet north of wagon road, west foot of small white hill; iron post stamped "5762 SOCR 1904"	5,767.597
Cactus Flat ranch, 6.8 miles west of, at southwest corner of section-house fence, 50 feet north of track; iron post stamped "6004 SOCR"	6,009.287
Water Canyon, 1.8 miles west of, 50 feet north of wagon road, at milepost 995; iron post stamped "5982 SOCR"	5,988.175
Water Canyon, 4.7 miles west of, at first telegraph pole east of milepost 998, 200 feet north of wagon road; iron post stamped "6034 SOCR"	6,039.410
Water Canyon, 7.8 miles west of, at crossing of road to Sanders ranch and to Polvadera, near warning post, 1,500 feet north of main road, 6-inch telegraph pole west of milepost 1001; iron post stamped "6267 SOCR"	6,272.481
NOTE.—The remainder of this line is a spur run direct and reverse.	
Magdalena, at road crossing, set near first telegraph pole east of station; iron post stamped "6556 SOCR"	6,561.282
Magdalena, 2 miles south of, 1,000 feet north of smelter, near telephone pole, 70 feet east of railroad, 70 feet north of wagon road, near road crossing; iron post stamped "6883 SOCR"	6,887.999
Kelly, 60 feet north of road, at right turn in road at west side of town, 100 feet west of shed at fence corner, in flat limestone rock 15 feet west of juniper tree; aluminum tablet stamped "7437 SOCR"	7,442.509
Kelly mine (Tri-Bullion Mining & Development Co.), 300 feet north of office building, 250 feet northwest of mouth of mine, on bank of arroyo near path, in gray porphyry rock ledge; aluminum tablet stamped "7688 SOCR"	7,693.314

Bench mark at road crossing northeast 7.7 miles to La Gencia triangulation station, near Sanders ranch, thence to bench mark on divide on Magdalena-Polvadera Road.

Sanders ranch, 3 miles north of road crossing, at gate to Sanders pasture, 10 feet east of gate; iron post stamped "6014"	6,019.762
Sanders ranch, about 0.5 mile east of, 8 miles north of road crossing, La Gencia, Triangulation station, at foot of juniper tree, in rock; aluminum tablet stamped "5785 SOCR"	5,790.661
Sanders ranch, about 4 miles east of, at gate on Water Canyon road, 10 feet north of gate; iron post stamped "5843 SOCR"	5,848.257
San Lorenzo Spring, 4 miles southwest of, top of main divide, 500 feet south of northeast corner of Sanders ranch fence; iron post stamped "5949 SOCR 1905 No. 3"	5,954.097

Gallina and Jemez Quadrangles.

RIO ARRIBA AND SANDOVAL COUNTIES.

The heights in the following list are based on an elevation at Cuba derived by precise leveling from preliminary values of the Coast and Geodetic Survey bench marks at Albuquerque.

The leveling in the Jemez quadrangle was done by M. S. Bright in 1905. That in the Gallina quadrangle was done by Bright in 1905, by A. R. Carver in 1906, and by F. A. Nussle in 1907.

JEMEZ QUADRANGLE.

The Divide west via Senorito post office to point 2.5 miles southeast of Cuba.

	Feet.
The Divide, 2 miles southwest of, west side of stream, 80 feet east of corral, 8 feet west of road, in outcrop of limestone rock; aluminum tablet stamped "147"	8,480.501
The Divide, 3 miles southwest of, 6 feet west of road summit, in south root of 28-inch pine tree; nail	8,462.10
The Divide, 4 miles southwest of, in south root of 26-inch pine tree; nail	8,368.71
The Divide, 5.25 miles southwest of, about 100 feet south of road, 250 feet north of creek, 25 feet north of old road, in granite outcrop; aluminum tablet stamped "150"	8,167.333
The Divide, 7.25 miles southwest of, 50 feet north of road, in south root of 28-inch leaning pine tree; nail	8,468.34
Copper City Gap, 8 feet south of road summit, in north root of 14-inch cottonwood tree; nail	8,733.81
Copper City Gap, 0.25 mile west of, in canyon, 4 feet south of road, in sandstone outcrop; aluminum tablet stamped "154"	8,664.779
Copper City Gap, 2.8 miles southwest of, west side of canyon, 8 feet east of road, in west root of 50-inch pine tree; nail	7,583.74
Senorito post office (Copper City), 25 feet north of north edge of road, in sandstone outcrop; aluminum tablet stamped "157"	7,317.950
Copper City, 2.5 miles west of, at top of ridge, 150 feet west of road forks; iron post stamped "159"	7,210.196

GALLINA QUADRANGLE.

Cuba southeast 2.5 miles.

Cuba, northeast corner of yard fence around E. A. Miera's residence; iron post stamped "100"	6,898.051

Cuba north to Gallina, thence southeast 7 miles, thence south to the divide near Penas Negras.

Cuba, 3.25 miles north of, about 0.25 mile north of road on hillside, south side of ridge, 120 feet east of road, in sandstone outcrop; aluminum tablet stamped "103"	7,163.150
La Jara, 0.25 mile west of, 150 feet north of lake, at top of slight ridge, 30 feet south of road; iron post stamped "106"	7,119.163
La Jara, 2.25 miles northwest of, on ridge 10 feet west of road summit, in east root of 28-inch pine tree; nail	7,233.600
La Jara, 3.25 miles north of, about 700 feet south of road forks, on north slope of hill, 8 feet east of road; iron post stamped "109"	7,220.713
La Jara, 4.5 miles north of, 25 feet east of road forks, in west side of 30-inch pine tree; nail	7,257.06
La Jara, 7 miles north of, on spur of ridge 10 feet west of road, 200 feet south of road forks; iron post stamped "112"	7,427.546
La Jara, 9.25 miles north of, at top of divide, 15 feet east of road, in west root of 22-inch piñon tree; nail	7,565.81

	Feet.
La Jara, 10.8 miles north of, on ridge, east side of road forks at summit; iron post stamped "115"	7,559.099
Gallina, 2.3 miles west of, sec. 7, T. 23 N., R. 1 E., on ridge 6 feet south of summit; iron post stamped "118"	7,414.626
Gallina, 1.2 miles west of, 60 feet southeast of road forks, at south edge of bottom, in north root of 15-inch dead piñon tree; nail	7,291.37
Gallina, 1 mile east of, sec. 15, T. 23 N., R. 1 E., in lane, 700 feet north of ranch house, 50 feet north of road fork, 8 feet south of fence, in sandstone outcrop; aluminum tablet stamped "121"	7,581.41
Gallina, 2.25 miles east of, 20 feet north of road, 400 feet west of house, south side of canyon, in north root of 24-inch pine tree; nail	7,617.79
Gallina, 3.25 miles east of, 300 feet east of road forks, 10 feet south of road, in north side of 30-inch dead pine tree; nail	7,708.15
Gallina, 4.5 miles east of, at a point where road enters timber, 110 feet east of road forks, 18 feet south of road, in sandstone bowlder; aluminum tablet stamped "124"	7,835.029
Gallina, 7.5 miles east of, in road fork, in standstone outcrop; aluminum tablet stamped "127"	7,766.834
Agua Sacra, 1.8 miles south of, 16 feet east of road, north side of canyon, in west root of 24-inch pine tree; nail	8,016.62
T. 22 N., R. 2 E., sec. 9, 2.5 miles south of Agua Sacra, 430 feet north of canyon, 40 feet west of road, in sandstone outcrop; aluminum tablet stamped "130"	8,150.214
Rio Paleo Ford, 300 feet east of, in road forks, in east root of 36-inch pine tree; nail	7,970.62
T. 22 N., R. 2 E., sec. 22, 1.25 miles south of Rio Paleo, 6 feet west of road summit, in gap, set in sandstone rock; aluminum tablet stamped "133"	8,397.296
Rio Puerco Ford, 1 mile east of, on west side of canyon, 4 feet west of road on south side of river, in east root of 30-inch pine tree; nail	8,183.89
T. 22 N., R. 2 E., south side of section 35, 2 miles southeast of Rio Puerco Ford, west side of Bonito Canyon, 10 feet west of road, in sandstone outcrop; aluminum tablet stamped "136"	8,182.354
T. 21 N., R. 2 E., sec. 13, 6 miles south of Rio Puerco Ford, west side of draw, 35 feet west of road at foot of sandstone bluff, 600 feet north of hay field, in sandstone outcrop; aluminum tablet stamped "140"	8,595.816
Rio Puerco Ford, 7.8 miles south of, in gap on west side of road summit, in east root of 38-inch pine tree; nail	8,954.69
T. 21 N., R. 2 E., sec. 27, 160 feet east of Penas Negras ranch house, 10 feet west of road, in west side of canyon, in limestone outcrop; aluminum tablet stamped "143"	8,702.186
The Divide, in gap at top of, 45 feet west of road summit, at base of 30-inch pine tree, on limestone bowlder; center of paint circle	9,027.20

Gallina north to point 3 miles north of Ferran ranch, thence east to mouth of Rio Puerco, thence southeast and southwest to Coyote, thence west to point 7.5 miles east of Gallina.

Rock Hut, 150 feet west of, 35 feet west of road, 160 feet north of forks, 200 feet east of river, on granite bowlder; center of paint circle	7,219.04
Leon Belarde ranch house, 1 mile northeast of, 900 feet north of road forks, east toe of hill, 10 feet west of road; iron post stamped "165"	7,161.229

	Feet.
Ferran ranch house, 0.25 mile south of, west toe of hill, north side of road, 165 feet north of forks, set in sandstone outcrop; aluminum tablet stamped "168"	6,980.399
Ferran ranch, 3 miles north of, on west side of river in road forks; iron post stamped "171"	6,883.324
Head of canyon on Gallina River, 1 mile east of, on south side of canyon 60 feet south of river, in willow grove; iron post stamped "174"	6,782.014
Head of canyon on Gallina River, 2.8 miles east of, 60 feet north of road, on north side of river, about 0.5 mile west of ranch house, in east side of 14-inch leaning cottonwood tree; nail	6,740.78
Chupadero ranch, 1.25 miles east of, about 200 feet north of wall of canyon, 70 feet south of river, between two cottonwood trees; iron post stamped "177"	6,644.993
Chupadero ranch, 4.25 miles east of, about 500 feet east of old gate and fence, 150 feet west of Sagebrush Flat, 300 feet south of river, 5 feet north of 14-inch leaning piñon tree, 6 feet south of road; iron post stamped "180"	6,499.569
Mouth of Gallina River, 1.25 miles southeast of, 60 feet east of road, 75 feet east of pole hut on west bank of Chama River, in west root of 14-inch double post-oak tree; nail	6,419.31
Mouth of Gallina River, 1.8 miles southeast of, in timber on hillside 60 feet south of edge of bluff, 10 feet south of road; iron post stamped "183"	6,449.658
Burns ranch, 0.6 mile west of, 5 miles east of mouth of Gallina River, 125 feet south of flume, 50 feet south of road, 8 feet north of wire fence, on east bank of wash, on sandstone; center of cross	6,392.80
Burns ranch, 0.6 mile west of, 5 miles east of mouth of Gallina River, 125 feet south of flume, 50 feet south of road, 9 feet north of wire fence, in east bank of wash, in sandstone 6 inches east of cross; aluminum tablet stamped "187½"	6,392.918
Burns ranch house, 0.8 mile southeast of, 20 feet east of gate at south entrance to farm, in west root of 24-inch cottonwood tree; nail	6,303.88
Burns ranch, 2.8 miles east of, 200 feet north of river, 75 feet north of road, at foot of hills, in limestone rock 6 inches west of painted circle; aluminum tablet stamped "190½"	6,269.290
Burns ranch, 7 miles southeast of, 250 feet east of cut, on south edge of railroad grade, in sandstone outcrop at foot of bluffs, 6 inches south of painted circle; aluminum tablet stamped "194½"	6,175.725
Mouth of Rio Puerco, 0.8 mile south of, east of river, 60 feet south of old house, in sandstone outcrop 6 inches west of painted circle; aluminum tablet stamped "196½"	6,208.783
Gallegos ranch, about 4.5 miles southeast of, northeast side of crossroads, mound on north and pit on east, in sandstone; aluminum tablet stamped "198½"	6,528.719
Gallegos ranch, 7.8 miles southeast of, in forks of Coyote and Abiquiu and Coyote and Amarilla Roads, in volcanic rock 2 inches west of paint circle; aluminum tablet stamped "201½"	6,847.643
Rito, 0.8 mile southwest of, 200 feet south of road, 100 feet west of stream, in east root of 14-inch post-oak tree; nail	6,712.29
Rito, 2 miles southwest of, 40 feet west of road, west side of ridge, in sandstone bowlder 12 feet north of volcanic bowlder; aluminum tablet stamped "204½"	6,652.977

	Feet.
Coyote, 1.25 miles southwest of, 25 feet north of road, in sandstone outcrop 1 foot north of paint circle; aluminum tablet stamped "207½"	6,771.946
Coyote, 4.8 miles west of, south edge of road, 12 feet northeast of leaning piñon tree 14 inches in diameter; in sandstone bowlder; aluminum tablet stamped "210½"	7,290.395
Coyote, 6.8 miles west of, 30 feet north of road, in west root of 18-inch piñon tree; nail	7,760.64

Point 3 miles north of Ferran ranch north 9 miles along Elvado Road.

Ferran ranch, 3 miles north of, in road forks; iron post	6,883.324
Ferran ranch, 5.7 miles north of, 300 feet east of Little Gallina Arroyo, in road forks west of point of ridge; iron post stamped "6941"	6,950.118
Ferran ranch, 8.4 miles north of, 500 feet east of sandstone bluff, 75 feet south of summit, in road forks; iron post stamped "7289"	7,298.320
Ferran ranch, 11.2 miles north of, 10 feet east of road, 20 feet southwest of blazed piñon tree, on top of ridge; iron post stamped "9"	7,153.147

Point 3 miles north of Ferran ranch north 10 miles along Stinking Lakes Road.

Ferran ranch, 5.6 miles north of, 20 feet east of road, 30 feet southeast of blazed cedar tree, in top of sandstone outcrop; aluminum tablet stamped "114"	7,035.647
Ferran ranch, 8.1 miles north of, 100 feet east of road, on top of ridge, 20 feet east of blazed cedar tree, in top of sandstone bowlder; aluminum tablet stamped "112"	7,159.714
Ferran ranch, 11 miles north of, 10 feet west of road, on top of ridge, 30 feet southwest of blazed piñon tree, in top of limestone outcrop; aluminum tablet stamped "109"	7,318.150

Dulce, Flora Vista, Monero, Stony Butte, and Turley Quadrangles.

RIO ARRIBA AND SAN JUAN COUNTIES.

The elevations in the following list are based on an elevation at Cuba determined by precise leveling from Yuma, checked by and adjusted to preliminary heights of bench marks near Albuquerque determined by precise leveling of the Coast and Geodetic Survey in 1909–10, through primary levels in the Gallina quadrangle. Several yard errors occurred during the progress of this work, most of which have been rectified upon final computation and by the rerunning of certain portions by Nussle, but there still remains an uncertainty of 3 feet in the elevations given in part of this list, which can not be corrected unless further field work is done.

Most of the leveling was done in 1906 by A. R. Carver. A part of that in the Monero and Dulce quadrangles was done in 1907 by Fred A. Nussle.

MONERO QUADRANGLE.

Point 12 miles north of Ferran ranch north to Elvado, thence west around Middle Stinking Lake and south to point 11 miles north of Ferran ranch.

	Feet.
Ferran ranch, 15.3 miles north of, 10 feet east of road on top of small summit, 500 feet east of sandstone bluff; iron post	6,935.918
Elvado, 3.1 miles south of, 10 feet east of road on top of ridge, 20 feet west of dead piñon tree; iron post	7,248.601
Elvado, railroad crossing; top of east rail	6,794.68
Elvado, Burns & Biggs Lumber Co.'s store, at northwest corner; iron post	6,807.665
Horse Lake Junction, 3.6 miles south of, 60 feet east of track, 75 feet south of arroyo; iron post stamped "86"	6,857.702
Ferran ranch, 28 miles north of, 75 feet north of road, 75 feet south of foot of sandstone bluff; iron post stamped "B. M. 90"	7,068.867
Middle Stinking Lake; surface of water, Aug. 26, 1906	7,093
Stinking Lake, 1,000 feet west of, at foot of sandstone bluff, 5 feet east of road, in top of sandstone bowlder; aluminum tablet stamped "93"	7,120.750
Stinking Lake, 3 miles west of, 15 feet north of road, top of ridge, in top of sandstone bowlder; aluminum tablet stamped "96"	7,137.101
Stinking Lake, 5 miles west of, 10 feet west of road, on top of ridge; nail in east root of 18-inch cedar tree, marked "B. M.–98"	7,170.66
Stinking Lake, 6 miles west of, 75 feet north of road, on side of ridge, in top of granite bowlder; aluminum tablet stamped "99½"	7,161.400
Stinking Lake, 7 miles southwest of, 10 feet east of road; nail in east root of 12-inch pine tree, marked "B. M. 100"	7,231.05
Stinking Lake, 9 miles southwest of, 60 feet west of road, at southeast end of ridge, in base of large sandstone bowlder; aluminum tablet stamped "102"	7,117.730
Stinking Lake, 12 miles southwest of, 12 feet west of road, 100 feet west of corral, 100 feet north of ridge, in top of sandstone outcrop; aluminum tablet stamped "106"	7,002.887
Stinking Lake, 3.1 miles west of, 100 feet north of road, on side of hill, in top of sandstone bowlder; aluminum tablet stamped "119"	7,201.896

Elvado north to Lumberton, thence northwest to Dulce, thence south to Elvado.

Gurule ranch, 1.2 miles north of, 9 feet west of road, 15 feet south of bridge over arroyo, on top of small hill; iron post stamped "22"	6,918.829
Gurule ranch, 2.8 miles north of, 10 feet north of road at summit, 5 feet south of blazed piñon tree, 0.8 mile west of road forks; top of stake	7,042.99
Gurule ranch, 4.4 miles north of, 12 feet west of road, 10 feet east of arroyo, 1 mile north of railroad; iron post 25	7,050.902
Gurule ranch, 7.5 miles north of, 42 feet east of railroad track, 10 feet east of road; iron post	7,288.272
Gurule ranch, 10.7 miles north of, at summit, 10 feet west of road, in east root of 22-inch pine stump; nail	7,459.86
Gurule ranch, 11.3 miles north of, 12 feet east of road, 21 feet south of scrub white oaks, 100 feet west of black butte; iron post	7,543.173

	Feet.
Gurule ranch, 13.3 miles north of, 6 feet east of road on side of small ridge, in west root of 22-inch dead pine tree; nail	7,625.92
Horse Lake, 500 feet south of, in road forks; iron post 35	7,684.933
Horse Lake, surface of water, August 11, 1906	7,669.36
Horse Lake, 2.4 miles north of, at summit, 12 feet east of road; iron post 38	7,631.759
Horse Lake, 3.4 miles north of, 30 feet east of road, on side of ridge, in west root of 22-inch pine tree; nail	7,598.63
Horse Lake, 4.4 miles north of, 50 feet east of road, 300 feet east of log cabin, 50 feet west of corral, in east root of 22-inch pine tree; nail	7,523.64
Horse Lake, 5.3 miles north of, in road forks, at summit; iron post 41	7,699.976
Monero, 66 feet west of Denver & Rio Grande Ry. track, 15 feet east of Rio Arriba Coal Co.'s store, 6 feet northeast of steps; iron post 44	7,246.866
Monero, in front of station; top of rail	7,245.03
Monero, 3.4 miles northwest of, 0.1 mile south of milepost D-367, opposite Amargo signboard, 75 feet west of track, in line of telegraph poles; iron post 48	7,000.055
Amargo, in front of signboard; top of rail	7,003.20
Lumberton, in front of station; top of rail	6,849.15
Lumberton, at northwest corner of Archuleta Mercantile Co. store; iron post 51	6,847.102
Lumberton, 50 feet north of station; United States Geological Survey astronomical station; bronze tablet stamped "L 36-55-48, L 106-56-15, 1897"	6,849.917
Lumberton, 0.4 mile west of, United States Geological Survey triangulation station west base, 60 feet south of track; iron post	6,840.711
Dulce, 3.5 miles southeast of, at summit, 10 feet east of road, 30 feet northwest of pine tree; iron post 59	7,198.890
Dulce, 4.5 miles southeast of, 6 feet east of road, in flat draw, in top of 10-inch pine stump; nail	7,205.19
Dulce, 6.7 miles southeast of, 30 feet east of road, 60 feet east of Burns-Biggs Lumber Co.'s track, on side of knoll; iron post	7,277.877
Dulce, 10 miles southeast of, 50 feet east of track, 25 feet east of trail, on side of ridge; iron post stamped "65"	7,603.812
Dulce, 12.9 miles southeast of, 30 feet west of track, at summit; iron post stamped "68"	7,671.946
Dulce, 16 miles southeast of, 50 feet east of track, on side of ridge; iron post stamped "71"	7,577.700
Dulce, 19.2 miles southeast of, 50 feet east of track, 1,000 feet south of sandstone bluff, on grade; iron post stamped "74"	7,262.777
Dulce, 23.4 miles south of, 50 feet east of track, 10 feet south of arroyo at summit; iron post stamped "78"	7,149.805
Horse Lake Junction, 75 feet west of track, 30 feet east of road; iron post stamped "82"	6,989.654

Lumberton north to Edith.

Edith, northwest corner of New Mexico Lumber Co.'s commissary building, in top of sandstone post; aluminum tablet stamped "314"	7,037.456
Edith, 3.8 miles south of, in road forks, 75 feet west of track, in top of sandstone post; tablet stamped "317"	6,966.414

DULCE QUADRANGLE.

Dulce northwest along railroad to Colorado line.

	Feet.
Dulce, at northwest corner of Jicarilla Apache Indian agency; iron post	6,769.086
Navajo River, surface of water, July 19, 1907	6,570
Navajo, pump house, 150 feet north of track, 50 feet north of road; 125 feet northwest of signboard "Navajo," in sandstone bowlder; aluminum tablet	6,582.809
Milepost 384, 250 feet southeast of, 30 feet north of track, in sandstone bowlder; aluminum tablet	6,414.815

Point 4 miles west of Stinking Lakes west along road to point 40 miles west of Stinking Lakes.

Stinking Lakes, 5 miles west of, 100 feet south of road, in north root of 20-inch pine tree; nail, marked "B.M. 121"	7,303.54
Stinking Lakes, 5.8 miles west of, 75 feet north of road, in top of sandstone bowlder; aluminum tablet stamped "122"	7,337.534
Stinking Lakes, 7 miles west of, 10 feet south of road, near top of Continental Divide, in root of 36-inch pine tree; nail, marked "B.M. 123"	7,481.77
Stinking Lakes, 9 miles west of, 15 feet south of road, on side of hill, in top of sandstone outcrop; aluminum tablet stamped "125"	7,248.525
Stinking Lakes, 12 miles west of, 15 feet south of road, on top of ridge, 30 feet northeast of dead pine tree, in top of sandstone outcrop; aluminum tablet stamped "128"	7,132.637
Stinking Lakes, 15.8 miles west of, 18 feet north of road, in gap, in top of sandstone outcrop; aluminum tablet stamped "131"	7,062.747
Stinking Lakes, 17.8 miles west of, 30 feet north of road, 0.5 mile west of top of divide, in root of 16-inch pine tree; nail, marked "B.M. 133"	7,267.09
Stinking Lakes, 18.8 miles west of, 75 feet north of road, on side of hill, 1,000 feet west of road forks, in top of sandstone bowlder; aluminum tablet stamped "134"	7,198.070
Stinking Lakes, 19.9 miles west of, 30 feet south of road; in base of 16-inch pine tree; spike marked "B.M. 135"	7,238.34
Stinking Lakes, 20.2 miles west of, 15 feet south of road, 200 feet west of road forks, 30 feet northeast of blazed pine tree, in top of sandstone outcrop; aluminum tablet stamped "136"	7,224.699
Stinking Lakes, 21.2 miles west of, 15 feet south of road, in south root of 24-inch pine tree; nail, marked "137"	7,222.00
Stinking Lakes, 23.3 miles west of, 10 feet east of road, on top of divide, in west root of 16-inch pine tree; nail, marked "B.M. 139"	7,515.35
Stinking Lakes, 24.4 miles west of, 10 feet east of road, on side of ridge, in top of large sandstone outcrop; aluminum tablet stamped "140"	7,497.076
Stinking Lakes, 27.6 miles west of, 15 feet north of ridge, 30 feet north of arroyo, in Munyon's Canyon, in top of sandstone bowlder; aluminum tablet stamped "143"	6,782.754
Stinking Lakes, 30.9 miles west of, 10 feet north of road, on side of ridge, in top of large sandstone outcrop; aluminum tablet stamped "146"	6,780.831
Stinking Lakes, 34.6 miles west of, 30 feet north of road, 80 feet north of small lake, in top of sandstone outcrop; aluminum tablet stamped "150"	6,479.149

	Feet.
Stinking Lakes, 38.2 miles west of, 15 feet south of road, on toe of ridge, in top of sandstone bowlder; aluminum tablet stamped "153"	6,348.356
Stinking Lakes, 40.5 miles west of, 30 feet south of road, at base of sandstone bluff, in top of sandstone outcrop; aluminum tablet stamped "156"	6,272.242

TURLEY QUADRANGLE.

Point 44 miles west of Stinking Lakes northwest to Archulite ranch, thence southwest to point 7 miles southwest of Blanco, thence north via Aztec to Colorado line.

Stinking Lakes, 43.7 miles west of, 10 feet north of road forks at base of sandstone cliff, in top of sandstone bowlder; aluminum tablet stamped "159"	6,211.469
Lake Gomez, 90 feet east of, 50 feet east of road, 90 feet west of corral, 150 feet west of hut, in top of sandstone bowlder; aluminum tablet stamped "162"	6,114.913
NOTE.—Arbitrary adjustment of 3 feet was placed here on account of color discrepancy.	
Lake Gomez, 3 miles west of, 75 feet north of road, at base of sandstone cliff, where road comes out of arroyo, in top of sandstone bowlder; aluminum table stamped "164"	5,966.609
Lake Gomez, 6 miles west of, 10 feet south of road, on top of ridge, in top of sandstone outcrop; aluminum tablet stamped "167"	5,848.264
Archulite ranch, 150 feet east of house, 200 feet south of corral, on small knoll, in top of sandstone outcrop; aluminum tablet stamped "169"	5,667.669
Archulite ranch, 2.9 miles west of, top of mesa, in top of sandstone outcrop; aluminum tablet stamped "171"	5,715.448
Adobe house, 600 feet west of, in road forks, in top of sandstone outcrop; aluminum tablet stamped "174"	5,631.394
Blanco, at southeast corner of F. T. Amiot's store, in top of sandstone outcrop; aluminum tablet stamped "178"	5,561.000
Blanco, 3.1 miles south of, 20 feet north of road, on west bank of arroyo, in top of large sandstone bowlder; aluminum tablet stamped "181"	5,552.024
Blanco, 6.9 miles southwest of, in crossroads, 100 feet south of old foundation, in sandstone outcrop in top; aluminum tablet stamped "184"	5,510.473
Aztec, 5.5 miles south of, 10 feet north of road, 75 feet east of arroyo, in top of sandstone outcrop; aluminum tablet stamped "188"	5,698.534
Aztec, 5.8 miles northeast of, in road forks, 100 feet west of milepost D-476; iron post stamped "199"	5,786.939
Aztec, 8.8 miles northeast of, 50 feet west of milepost D-473, in line of telegraph poles; iron post stamped "202"	5,831.633
Aztec, 11.9 miles northeast of, 6 feet south of fourth telegraph pole north of milepost D-470; aluminum tablet stamped "205"	5,897.205

Colorado-New Mexico line near La Boca, Colo., south to Archulite ranch.

La Boca, 2.6 miles south of, 15 feet east of road in river bottom, in base of dead cottonwood tree; spike, marked "B. M. 337"	6,090.55
Louis F. Welmar ranch, in road forks; iron post stamped "338"	6,062.496

	Feet.
Welmar ranch, 3.2 miles south of, 10 feet west of road, in base of cottonwood tree; spike, marked "B. M. 340"	5,981.42
Welmar ranch, 4.4 miles south of, 15 feet west of road, in base of cottonwood tree; spike, marked "B. M. 341"	5,949.26
Welmar ranch, 6.3 miles south of, 20 feet east of road; iron post stamped "343"	5,901.278
Lopez ranch, 1.7 miles south of, 10 feet west of road, in top of south point of large sandstone bowlder; aluminum tablet stamped "346"	5,821.195
Pine River and San Juan River, forks of, 4 feet north of Walter Von Buddenbrock ranch house; iron post stamped "348"	5,769.655
Von Buddenbrock ranch, 3.2 miles southwest of, 20 feet north of road, at base of sandstone bluff, opposite fence corner, in top of sandstone bowlder; aluminum tablet stamped "350"	5,737.386
Von Buddenbrock ranch, 4.8 miles west of, 10 feet west of road, near top of ridge, in small piñon tree; 8-penny nail, marked "B. M. 351"	5,780.56
Von Buddenbrock ranch, 6.1 miles west of, at base of hill at fence corner, in top of large sandstone bowlder; aluminum tablet stamped "352"	5,724.635

FLORA VISTA QUADRANGLE.

Point 2.2 miles south of Aztec north via Aztec to point 3.4 miles northeast of Aztec.

Aztec, 2.2 miles south of, 75 feet east of road forks, on side of ridge, in top of sandstone outcrop; aluminum tablet stamped "191"	5,756.817
Blanco, 15.7 miles west of, 60 feet west of track, near road forks, in ground at base of telephone pole, hub; marked "B.M. 5643.84" (railway bench mark)	5,634.87
Aztec, northwest corner of courthouse; iron post stamped "193"	5,647.739
Aztec, 1.9 miles north of, on east guard rail on bridge, 500 feet north of milepost "D-480," top of south bolthead; marked "B.M. 195"	5,699.20
Aztec, 3.4 miles northeast of, in line of telegraph poles, 0.4 mile north of milepost D-479; iron post stamped "196"	5,753.462

Point 7 miles southwest of Blanco west to Farmington, thence northeast to Aztec.

Bloomfield, 1 mile west of, 15 feet north of road, 50 feet north of fence corner; iron post stamped "358"	5,427.092
Bloomfield, 5.3 miles west of, 10 feet north of road, on top of ridge; iron post stamped "362"	5,575.525
Farmington, 5.1 miles east of, 15 feet north of road, at base of ridge; iron post stamped "365"	5,317.938
Farmington, 2.5 miles east of, in road forks, at fence corner; iron post stamped "367"	5,371.800
Farmington, 0.4 mile east of, 20 feet south of railway, in base of cottonwood stump; tenpenny nail, marked "5286.83" (railroad bench mark)	5,289.66
Farmington, 12 feet north of city hall; iron post stamped "370"	5,308.988
Farmington, in cement door sill of the Pierce Mercantile Co. store; aluminum tablet stamped "371"	5,309.914
Farmington, 3.1 miles north of, 20 feet west of milepost D-493, 15 feet east of wagon road; iron post stamped "374"	5,364.105

	Feet.
Farmington, 4.1 miles north of, 10 feet west of milepost D-492, in base of telegraph pole; spike, marked "5385.80" (railroad bench mark)	5,375.48
Farmington, 6.1 miles north of, 75 feet west of wagon road, 50 feet east of railroad at milepost D-490; iron post stamped "377"	5,457.345
Flora Vista, at northeast corner of Mullarky's general store; iron post stamped "380"	5,507.099
Flora Vista, 1.5 miles north of, at milepost D-486, in base of telegraph pole; spike, marked "5525.18" (railroad bench mark)	5,514.70
Flora Vista, 3.5 miles north of, 15 feet west of wagon road, 50 feet east of railroad track, at fence corner; iron post stamped "384"	5,590.277

Point 3 miles west of Bloomfield south to Simpson's trading station, thence southwest to triangulation station, thence north to Farmington (azimuth).

Bloomfield, 3 miles west by 3 miles south of, 20 feet west of road, on top of ridge; iron post stamped "387"	5,494.040
Bloomfield, 3 miles west by 7 miles south of, 15 feet east of road, on top of ridge; iron post stamped "391"	5,831.870
Bloomfield, 3 miles west by 10 miles south of, 15 feet east of road, top of small ridge; iron post stamped "394"	5,770.590
Simpson's trading post, 20 feet southeast of store; iron post stamped "396"	5,734.488
Simpson's, 3.2 miles southwest of, 1,000 feet northeast of road forks, 20 feet north of road; iron post stamped "399"	5,985.638
Simpson's, 6.9 miles south of, 20 feet west of road, on small ridge; iron post stamped "402"	6,267.650
Farmington, 21.53 miles south of, 20 feet east of road, at foot of large sand hill; iron post stamped "408"	6,268.082
Azimuth triangulation station, 18.43 miles southwest of Farmington, 0.6 mile east of Lizniszin Road, in top of sandstone bowlder; aluminum tablet stamped "411"	6,218.402
Farmington, 14.8 miles southwest of, 20 feet east of road, on small ridge; iron post stamped "415"	5,962.722
Farmington, 11.6 miles southwest of, 20 feet east of road; iron post stamped "418"	5,790.079
Dune triangulation station, 8.2 miles southwest of Farmington, 1 mile southeast of road forks of Simpson and Gallup Roads, 70 feet south of Simpson Road; iron post stamped "421"	6,078.897
Farmington, 7.2 miles southwest of, in road forks of Simpson and Gallup Road forks; iron post stamped "422"	5,982.742
Farmington, 6 miles southwest of, top of long hill, 10 feet south of road, in top of rim rock; aluminum tablet stamped "423"	5,763.950
Farmington, 2.7 miles west of, at road forks, 30 feet west of fence; iron post stamped "426"	5,244.298
Farmington, 2.5 miles west of, 60 feet south of road, near road forks of La Plata and Gallup Roads, in stump of cottonwood tree; spike, marked "5265.06" (old railway bench mark)	5,268.31

STONY BUTTE QUADRANGLE.

Bench mark near Simpson triangulation station (portion of circuit—Bloomfield to Farmington).

Simpson triangulation station, 9.9 miles south of Simpson's, 150 feet north of road, on edge of high mesa; iron post stamped "405"	6,582.8

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	Feet.
Welmar ranch, 3.2 miles south of, 10 feet west of road, in base of cottonwood tree; spike, marked "B. M. 340"	5,981.42
Welmar ranch, 4.4 miles south of, 15 feet west of road, in base of cottonwood tree; spike, marked "B. M. 341"	5,949.26
Welmar ranch, 6.3 miles south of, 20 feet east of road; iron post stamped "343"	5,901.278
Lopez ranch, 1.7 miles south of, 10 feet west of road, in top of south point of large sandstone bowlder; aluminum tablet stamped "346"	5,821.195
Pine River and San Juan River, forks of, 4 feet north of Walter Von Buddenbrock ranch house; iron post stamped "348"	5,769.655
Von Buddenbrock ranch, 3.2 miles southwest of, 20 feet north of road, at base of sandstone bluff, opposite fence corner, in top of sandstone bowlder; aluminum tablet stamped "350"	5,737.386
Von Buddenbrock ranch, 4.8 miles west of, 10 feet west of road, near top of ridge, in small piñon tree; 8-penny nail, marked "B. M. 351"	5,780.56
Von Buddenbrock ranch, 6.1 miles west of, at base of hill at fence corner, in top of large sandstone bowlder; aluminum tablet stamped "352"	5,724.635

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Point 2.2 miles south of Aztec north via Aztec to point 3.4 miles northeast of Aztec.

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Aztec, northwest corner of courthouse; iron post stamped "193"	5,647.739
Aztec, 1.9 miles north of, on east guard rail on bridge, 500 feet north of milepost "D-480," top of south bolthead; marked "B.M. 195"	5,699.20
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Bloomfield, 5.3 miles west of, 10 feet north of road, on top of ridge; iron post stamped "362"	5,575.525
Farmington, 5.1 miles east of, 15 feet north of road, at base of ridge; iron post stamped "365"	5,317.938
Farmington, 2.5 miles east of, in road forks, at fence corner; iron post stamped "367"	5,371.800
Farmington, 0.4 mile east of, 20 feet south of railway, in base of cottonwood stump; tenpenny nail, marked "5286.83" (railroad bench mark)	5,289.66
Farmington, 12 feet north of city hall; iron post stamped "370"	5,308.988
Farmington, in cement door sill of the Pierce Mercantile Co. store; aluminum tablet stamped "371"	5,309.914
Farmington, 3.1 miles north of, 20 feet west of milepost D-493, 15 feet east of wagon road; iron post stamped "374"	5,364.105

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THE STATE GEOLOGICAL SURVEYS OF THE UNITED STATES.

Compiled under the direction of C. W. HAYES.

INTRODUCTION.

Information concerning State geological surveys is difficult or impossible to obtain. Much of it is scattered through many publications, and many facts regarding organization and methods are not published. Such information is in constant demand by cooperating State and Federal organizations, by persons interested in the organization of new State surveys, and by the State geologists themselves. It is the last named to whom the information is of greatest value, for many common problems of administration are met by all State geologists, and a statement of the successful solution of a problem by one will help others to solve the same problem. This need of accurate information was urgently expressed by the geologists and engineers in attendance at a conference held in Washington in the spring of 1910, and as a result of rather full discussion a committee was appointed to take charge of the matter. It seemed to the committee that the end in view could be best attained by requesting the heads of the several surveys to prepare statements regarding their organizations. Accordingly the following circular letter and outline were submitted to all State geologists and to all State engineers and other officials having cooperative relations with the Federal Survey.

TRENTON, N. J., *July 15, 1910.*

DEAR SIR: At the conference of the officials of the United States Geological Survey and the State geologists and heads of other cooperating bureaus held in Washington May 31–June 1, a committee was appointed to collect and compile information regarding the organization and work of the various surveys with a view to its early publication as a handbook of geological and hydrographic surveys in the United States. As all present at the conference seemed to wish the plan carried out, it is hoped that those absent will also find it attractive and will assist in its preparation.

In order that the statements may be accurate and comprehensive, it is desired that they be carefully prepared for publication by some official of the respective surveys, and that the subsequent work of compiling and editing be reduced to a minimum. To this end please follow as closely as possible the following out-

line, giving in narrative form explicit information on as many of the points mentioned as are applicable to your survey or bureau.

In order that the bulletin may be issued with reasonable promptness, please prepare and forward the data without delay to Dr. C. W. Hayes, United States Geological Survey, Washington, D. C.

Yours truly,

H. B. KÜMMEL, New Jersey,
C. W. HAYES, United States Geological Survey,
F. W. DE WOLF, Illinois,
W. MCCULLOH, New York,

Committee.

OUTLINE.

1. Give a brief résumé (600 to 800 words) of previous geological surveys or of antecedent scientific bureaus in your State, of which your bureau is the outgrowth, giving specifically the name of each, date, scope of work and accomplishments, and causes of discontinuance.

2. Give the exact name of the present survey or bureau and date of its organization.

3. Give a summary of the laws governing your survey which are now operative.

4. If not already given under 3, outline the organization of your survey under the following heads:

(*a*) Governing board. Name, number of persons, method of appointment, terms of office, compensation (if any) as members of this board (not salaries if they serve ex officio).

(*b*) Executive officer. Title, name of individual, method of appointment, date of appointment of present incumbent, term of office. If an ex officio appointment or other State or educational position is held, please state; give proportion of time spent on survey work. Indicate whether compensation is per diem or by regular monthly or annual salary; how fixed, whether by law or by rule of governing board.

(*c*) Subordinates. Group your subordinates into three classes—(1) clerical; (2) geologic, including chemical and technologic; (3) topographic, including engineering and hydrographic. For each of these classes give the approximate number of each class employed, their method of appointment (by the managing board, executive head, with or without intervention of civil-service commission, etc.), term of service, per diem or permanent, range of pay for different classes. It is particularly desired to know to what extent advanced college students or college professors are employed on surveys.

5. Appropriations. A. Please state how your appropriations are made, whether continuing, annual, biennial, or for any stated period. Are any contingent upon coöperation?

B. Do unexpended balances carry to a new fiscal year or do they lapse to the treasury? If the latter, how soon after the close of the year?

C. Give your annual appropriation, specifying objects, if so fixed by law.

D. Estimate in percentages the average expenditure under the following heads:

(*a*) Administrative and routine clerical; include only such part of the salary of the head of the survey and of others as may be charged to administrative work.

(*b*) Topographic, including field work and office work (not administrative).

(*c*) Economic, stratigraphic, and areal geology, including office work in preparation of reports.

(*d*) Statistical geology.

(*e*) Paleontologic geology as distinct from stratigraphic.

(*f*) Chemical work.

(*g*) Underground water resources.

(*h*) Drainage surveys.

(*i*) Stream flow and reservoir surveys.

(*j*) Testing road materials or other highway work, not including construction.

(*k*) Highway construction.

(*l*) Other technologic work.

(*m*) Other lines of work or combinations which can not be included under above heads, specifying nature of work.

6. Publications. A. Enumerate the various series of reports, bulletins, monographs, and maps published, giving the (*a*) number of volumes of each series so far issued, (*b*) size of editions, (*c*) method of distribution (if sold, give average annual income and its disposition—whether paid to State treasury, etc.).

B. Average annual cost of printing reports and accompanying maps for last five years or by volumes. Does this come from your Survey appropriation or from some other fund?

C. Do you have full control over printing your maps and reports, as to choice of printer, style of report, paper, illustrations, etc., contents of report? If not, state explicitly the nature of the limitations.

D. Do you have full control over distribution of your reports? What classes of persons and institutions are on your mailing list and how is it kept alive?

7. Present main lines of work, (1) by your bureau independently; (2) in cooperation (state nature and extent of cooperative work): (*a*) With the United States Geological Survey, (*b*) with geological surveys of other States, (*c*) with other bureaus of the National Government, (*d*) with other scientific bureaus of your own State.

It was hoped that by means of the above outline a fair degree of uniformity of treatment would be secured, and this hope has been in a measure realized. Necessarily some editing has been required, but this has been confined so far as possible to matters of form, arrangement, headings, etc. The delay in transmitting the material to press has been due to delay of the authors in furnishing it, although a number of requests of increasing urgency were sent to several of the delinquents.

It was originally intended that the bulletin should include all State organizations which cooperated with the United States Geological Survey in geology, topography, or hydrography, but only a few of the State officers other than the State geologists have complied with the request for a statement, and it has been decided to bring these together in an appendix, rather than in the body of the bulletin with the geological surveys, with which they are not readily comparable.

Thirty-six States recognize geologic work as a necessary and proper governmental function and have organizations for the carrying on of such work. The complete list of States and Territories

with names of organizations and names and titles of executive officers follows:

Alabama.—Geological Survey of Alabama; E. A. Smith, State geologist, University.

Arizona.—Geological Survey of Arizona; C. F. Tolman, Territorial geologist, Tucson.

Arkansas.—Geological Survey of Arkansas; A. H. Purdue, State geologist, Fayetteville.

California.—California State Mining Bureau; L. E. Aubury, State mineralogist, San Francisco.

Colorado.—Colorado State Geological Survey; R. D. George, State geologist, Boulder.

Connecticut.—State Geological and Natural History Survey; William North Rice, superintendent, Middletown.

Delaware.—Maintained Geological Survey of State of Delaware, 1837–1838.

Florida.—Florida State Geological Survey; E. H. Sellards, State geologist, Tallahassee.

Georgia.—Geological Survey of Georgia; S. W. McCallie, State geologist, Atlanta.

Illinois.—State Geological Survey; F. W. DeWolf, director, Urbana.

Indiana.—Department of Geology and Natural Resources; Edward Barrett, State geologist, Indianapolis.

Iowa.—Iowa Geological Survey; Samuel Calvin, State geologist, Iowa City.

Kansas.—State Geological Survey of Kansas; Erasmus Haworth, State geologist, Lawrence.

Kentucky.—Kentucky Geological Survey; C. J. Norwood, director, Lexington.

Louisiana.—Maintained Geological Survey in connection with the State Agricultural Experiment Station, 1891–1909.

Maine.—State Survey Commission; C. Vey Holman, State geologist, Bangor.

Maryland.—State Geological and Economic Survey; William Bullock Clark, State geologist, Baltimore.

Massachusetts.—Maintained Geological Survey of Massachusetts, 1830–1841.

Michigan.—Michigan Geological and Biological Survey; R. C. Allen, State geologist, Lansing.

Minnesota.—Maintained Geological and Natural History Survey, 1872–1900.

Mississippi.—Geologic, Economic, and Topographic Survey of Mississippi; E. N. Lowe, director of the State Geological Survey, Jackson.

Missouri.—Bureau of Geology and Mines; H. A. Buehler, director and State geologist, Rolla.

Nebraska.—Nebraska Geological Survey; Edwin H. Barbour, State geologist, Lincoln.

Nevada.—Maintained office of State mineralogist, 1866–1878.

New Hampshire.—Maintained Geological and Mineralogical Survey, 1840–1844; 1868–1878.

New Jersey.—Geological Survey of New Jersey; Henry B. Kümmel, State geologist, Trenton.

New York.—Science Division (Geological Survey) of the Educational Department; John M. Clarke, State geologist and paleontologist, State Museum, Albany.

North Carolina.—North Carolina Geological and Economic Survey; Joseph Hyde Pratt, State geologist, Chapel Hill.

North Dakota.—North Dakota Geological Survey; Arthur Gray Leonard, State geologist, Grand Forks.

Ohio.—Geological Survey of Ohio; J. A. Bownocker, State geologist, Columbus.

Oklahoma—Oklahoma Geological Survey; Charles N. Gould, director, Norman.

Oregon.—Maintained office of State geologist, 1872–1874.

Pennsylvania.—Topographic and Geological Survey Commission; Richard R. Hice, State geologist, Beaver.

Rhode Island.—Natural Resources Survey of Rhode Island; Charles W. Brown, superintendent, Providence.

South Carolina.—South Carolina Geological Survey; Earle Sloan, State geologist, Charleston.

South Dakota.—Geological Survey of South Dakota; E. C. Perisho, State geologist, Vermilion.

Tennessee.—Tennessee State Geological Survey; George H. Ashley, State geologist, Nashville.

Texas.—Maintained office of State geologist at various times from 1858–1892; University of Texas Mineral Survey, 1901–1904.

Vermont.—Geological Survey of Vermont, G. H. Perkins, State geologist, Burlington.

Virginia.—State Geological Survey of Virginia; Thomas Leonard Watson, director, Charlottesville.

Washington.—State Geological Survey of the State of Washington; Henry Landes, State geologist, Seattle.

West Virginia.—West Virginia Geological and Economic Survey; I. C. White, State geologist, Morgantown.

Wisconsin.—Wisconsin Geological and Natural History Survey; E. A. Birge, superintendent and director, Madison.

Wyoming.—Geological Survey of Wyoming; C. E. Jamison, State geologist, Cheyenne.

Idaho, Montana, New Mexico, and Utah have had no State surveys.

ALABAMA.

PREVIOUS SURVEYS.

The first step toward the systematic study of the geology of Alabama was taken in 1847 by the University of Alabama, when, on the appointment of Prof. Michael Tuomey to the professorship of geology of that institution, it was stipulated that each year a part of his time should be spent in geologic explorations in the State. In accordance with this arrangement he immediately began field studies, publishing in the newspapers of Tuscaloosa such extracts from his reports as might be of general interest. In recognition of this effort the State legislature, in January, 1848, appointed Prof. Tuomey State geologist, without salary, and requested him to make to that body a report of his work for publication by the State. Thus was begun the first geological survey of Alabama.

In 1849 Prof. Tuomey presented to the legislature his first report, which was published in 1850 by the State. The geologic map, however, appeared later.

Prof. Tuomey continued his explorations at the expense of the University of Alabama from 1848 to 1853. In 1854 the legislature

of Alabama passed an act to provide for a Geological and Agricultural Survey of the State. The sum of $2,500 was appropriated annually for the salary of the State geologist, and the further sum of $10,000 was appropriated to employ assistants and defray the expenses incidental to the office. The governor was authorized to appoint a State geologist, who during the period of his service should hold no other office in the State. The governor was also authorized to fill by appointment a vacancy in the office of State geologist should one occur before the completion of the survey. In other sections of this act the duties of the State geologist were defined.

Under this act Prof. Tuomey was appointed State geologist, and until his death in 1857 he devoted practically his whole time to the duties of the office. His headquarters were at the University of Alabama, where he occasionally delivered courses of lectures.

Prof. Tuomey's second report was submitted to the legislature in 1855, but was not published until after his death, although the legislature in February, 1856, ordered the printing of 3,000 copies. In April, 1857, immediately after the death of Prof. Tuomey, Dr. John W. Mallet was commissioned by Governor Winston to supervise the printing of the report. This report was published in 1858, together with the second geologic map of the State. In these two reports, with accompanying maps, the geologic subdivisions of Alabama were defined, and the future importance of the coal and iron deposits of the State were foreshadowed.

After the death of Prof. Tuomey the civil war and reconstruction problems overshadowed all other subjects, and no geologic work was carried on by the State until 1873. During this period, however, a commissioner of industrial resources was one of the regular officers of the State, and four short reports, embracing perhaps 20 or 30 pages each, were issued from that office between 1869 and 1874.

In 1871 the University of Alabama, upon its reorganization, again took the lead in geologic investigations by authorizing the professor of geology in that institution, Prof. E. A. Smith, the present State geologist, to spend a part of his time in geologic field work

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

"Geological Survey of Alabama" is the designation employed in the codes since 1873, when the present Survey was organized.

HISTORICAL SKETCH.

In 1873 the legislature passed an act "to revive and complete the Geological and Agricultural Survey of Alabama," appointed Prof. E. A. Smith, the present incumbent, State geologist, and appropri-

ated $3,000 for equipment and $500 a year for a period of 10 years for the expenses of the Survey, the State geologist to receive no salary from the State, his only compensation being that paid by the University for his services as a professor in that institution.

These conditions continued for the next 10 years, during which time the greater part of the State was visited and a number of reports were made, dealing mainly with the coal and iron resources and the agricultural features of the State. For most of this time Prof. Smith had the assistance of Henry McCalley, who also gave his services gratuitously to the Survey.

In 1883 the legislature increased the annual appropriation to $5,000 and in 1891 to $7,500. This made possible more effective work. Acting under it, Mr. McCalley was given general charge of investigations in the Warrior coal field and of the iron interests; Joseph Squire and A. M. Gibson were placed in charge of investigations in the Cahaba and Coosa coal fields, respectively; and Prof. Smith took charge of investigations in the metamorphic area and of studies of the Coastal Plain deposits.

Reports on all these regions were prepared and published in due course of time. Reports on the gold deposits were prepared by Dr. William B. Phillips, W. M. Brewer, and others. Dr. Phillips also prepared a report on iron making in Alabama, which quickly ran through two editions, and a proposed third edition is now in preparation. From Dr. Heinrich Ries was obtained a report on the clays of the State. The water resources were also investigated, and preliminary reports on the water powers and on the artesian and other underground waters of the State have been published. In the preparation of the water reports the United States Geological Survey cooperated; also in the preparation of the preliminary report on the Coastal Plain, the first outline of which was published as Bulletin 43 of the United States Geological Survey, under the joint authorship of E. A. Smith and L. C. Johnson.

In 1896 a geologic map of the State was published, with explanatory chart embodying all the information accumulated up to that time.

From the outset the ideal of the Survey has been to take account of all the State's natural resources—mineral, geologic, agricultural, and biologic. Through the liberality of T. H. Aldrich a bulletin on Tertiary fossils was issued in 1886, and under an arrangement with C. L. Herrick a partial report on the fresh-water and marine Crustacea of the State was published in 1888. Mr. Aldrich also contributed a preliminary list of the fresh-water mollusks of the State, which was published in the report for 1876. Material has been gradually accumulated, through donations and the collections of the Survey workers, for an account of various other forms of animal life native to Alabama, which may be published in due course of time.

A small preliminary list of the plants native to Alabama was published many years ago by Dr. Charles Mohr and Prof. E. A. Smith, and a monumental work on the plant life of Alabama was prepared by Dr. Mohr and published in 1901 in cooperation with the United States Department of Agriculture. It was the intention that Dr. Mohr should prepare another volume on the timbers and other plants, either useful or noxious, but his death interfered. This work was assigned to Dr. R. M. Harper, and the first installment of a report on the timber trees of the State is now in manuscript awaiting publication.

SUMMARY OF LAWS.

The functions of the Survey, as defined in the 1906 Code of Alabama, are as follows:

SEC. 689. *State geologist.*—Eugene A. Smith, professor of mineralogy and geology in the University of Alabama, is State geologist. In the event of a vacancy in the office of State geologist, from any cause, the professor of geology in the University of Alabama shall be ex officio State geologist.

SEC. 690. *His duties.*—It shall be the duty of the State geologist to devote such portions of his time as may not be required for the discharge of his duties as a professor in the University of Alabama to making exploration and examination of the mineral, agricultural, and other natural resources of the State, so as to determine accurately the quality and character of its soils and their adaptation to agricultural purposes, and especially to the occurrence and quality of phosphates, marls, gypsum, and other natural fertilizers; its mineral resources and their location, character, and capacity for development; its water powers and their capacities; its forest trees and their utilities and distribution; and it shall be the duty of him and his assistants, whenever they discover any valuable deposits of iron or other ore, coal, phosphates, marls, or other substances of value, to notify immediately the owners of the land upon which such deposits occur. He shall make to the legislature quadrennially a report of the progress of his explorations and examinations, together with analyses of soils, ores, minerals, and mineral waters, with maps, charts, and drawings, which report shall be printed and shall be the exclusive property of the State. He shall also make collections of specimens and illustrations of the geological and agricultural resources of the State, one of which shall be deposited in the cabinet of the University of Alabama, a second in the cabinet of the Alabama Polytechnic Institute, and a third in the office of the commissioner of agriculture and industries in the capitol at Montgomery.

SEC. 691. *Assistants.*—The State geologist shall have power to appoint, with the approval of the governor, such assistants, including a competent chemist, and for such periods and with such compensation as he may deem necessary to the best interests of the Survey.

SEC. 692. *Annual appropriation.*—There is appropriated, out of any funds in the treasury not otherwise appropriated, for the Geological and Agricultural Survey provided for in this chapter, annually, the sum of $7,500. Upon the requisition of the State geologist, when approved by the governor, the auditor shall draw his warrant on the treasurer for the amount appropriated, in such sums as may be needed from time to time for the purposes of the Survey herein provided for; and for all expenditures made under the provisions of this chapter, except for the payment of the salary of the State geologist, the

approval of the governor must be obtained, and the vouchers of the State geologist for all such expenditures must be filed with the auditor and a statement of his receipts and expenditures shall accompany each quadrennial report of the State geologist.

SEC. 693. *Salary.*—The State geologist shall receive out of the State treasury a salary of $100 a month as State geologist during the time he shall be engaged in performing his duties as professor of mineralogy and geology in and is paid a full professor's salary by the University of Alabama; and when not so employed and paid by the said university, he shall receive a salary of $200 a month, out of the State treasury, payable as other State officers' salaries are paid.

SEC. 694. *Expense of Survey.*—The balance of the annual appropriation herein provided for shall be devoted, so far as may be necessary to execute the purposes of this chapter, to the discharge of the expenses of the Survey, including the compensation of all temporary and permanent assistants; traveling expenses of the geologist and the geological corps in and out of the State; purchase of apparatus and material for making chemical analyses; other necessary expenditures for outfit; expenses incurred in providing for the transportation, arrangement, and proper exhibition of the geological and other collections made under authority of this chapter, and the engraving of maps and sections to illustrate the quadrennial reports of progress.

SEC. 695. *Bulletins of State geologist.*—Whenever the State geologist has in hand, ready for publication, material for a bulletin or any other report of his surveys and investigations of the mineral, agricultural, or other natural resources of the State, he shall report the same to the governor, and a committee consisting of the governor, secretary of state, and State geologist shall then determine the number of such bulletin or report which shall be printed and published.

SEC. 696. *Printing and binding geological bulletins.*—When the number of such bulletin or report to be printed or published has been so determined, the governor shall order the same to be printed and bound forthwith at such times and places, and in such manner and style as regards size, type, quality of paper, binding, etc., as said committee may deem best, and in similar manner he shall have engraved and printed all charts, maps, views, drawings, sketches, or details as may be deemed necessary by said committee to properly illustrate such bulletin or report. And for the purposes herein mentioned, when, in the opinion of said committee, the State printers are not prepared to do in proper manner any engraving or other work required for such report or bulletin, the governor may make special contracts with such persons, firms, or corporations, within or without the State, as in the judgment of said committee will secure the promptest and most satisfactory work.

SEC. 697. *Payment for printing and binding bulletins.*—The accounts for the printing, engraving, and binding done under the provisions of this chapter when approved by the governor, shall be paid by his order out of any moneys in the State Treasury.

ORGANIZATION.

The form of organization of the Survey is described in the foregoing code of laws.

There is no governing board, except that expenditures, aside from those of a routine nature, are first authorized by the governor, and for the reports and bulletins the governor, secretary of state, and

State geologist constitute a committee which decides as to the style of printing, illustrations, and binding, the size of the edition, and the firm or firms to which the work shall be assigned.

The executive officer of the Survey is the State geologist. Prof. Eugene A. Smith has held the office since his appointment by the legislature in 1873, when the Survey was revived. The term of office is not limited. The appointee must be the professor of geology in the State University. His duties and compensation are specified in the foregoing code of laws.

At present the assistants include a chief assistant, a chemist, a curator of the museum, a field assistant, and a stenographer. Temporary assistants for special work are employed as occasion arises. All employees are appointed, and their compensation is fixed by the State geologist with the consent of the governor. Professors and advanced students are occasionally employed.

APPROPRIATIONS.

The appropriations for the Survey are made annually, the sum of $7,500 being each year set aside for the purpose.

There are no unexpended balances, the money being drawn from the State treasury before the end of the fiscal year and placed in bank subject to check for payment of obligations incurred but not fully discharged before the end of the fiscal year.

Specific information as to allotments is not available. In a general way it may be said that the money has been expended chiefly in the preparation of reports of an economic nature, requiring, however, as a matter of course, more or less areal and stratigraphic work. The only paleontologic publication is a bulletin on Tertiary fossils, which, however, was contributed by T. H. Aldrich, who also bore the expense of printing. A partial report on the fresh-water and marine Crustacea of the State, prepared through the cooperation of C. L. Herrick, has also been issued, as well as a preliminary list of the fresh-water mollusks of the State, the latter contributed by Mr. Aldrich. One volume is devoted to underground waters and another to water powers. The former involved many chemical analyses. Two editions of a technologic report on iron making in Alabama have been exhausted and a third edition is in hand. A bulletin on road materials and highway work is in preparation.

PUBLICATIONS.

The publications of the Geological Survey of Alabama comprise a series of annual progress reports from 1874 to 1882, inclusive; a series of bulletins, numbered 1 to 9, inclusive; and 19 other special reports. These publications cover a wide range of subjects, but are chiefly

of an economic nature, though stratigraphic, areal, and paleontologic geology are represented. Many of the reports relate to special areas; others are of a more general character. The plant life of Alabama and the trees, water supplies, and water powers of the State are also included in the list of subjects studied. Preliminary reports on the fresh-water and marine Crustacea of the State and on the fresh-water mollusks have also been published, while a technologic report on iron making in Alabama has run through two editions and a third edition is about to be issued.

The usual edition is 2,500 copies, although of some reports editions of 5,000 and 10,000 copies have been printed.

The governor, the secretary of state, and the State geologist constitute the committee on printing. Under the law, in case the State printers are not prepared to prosecute in proper manner the printing and engraving of a report, "the governor may make special contracts with such persons, firms, or corporations, within or without the State, as in the judgment of said committee will secure the promptest and most satisfactory work."

Publications are distributed free of charge (except one, the price of which is $1 plus 16 cents for postage), but applicants are required to pay the postage. The distribution is in charge of the State geologist. The mailing list includes a number of public libraries in Alabama and other States, all geological surveys in the United States and many foreign surveys, and geologists of America and other countries. The mailing list is kept alive by sending out notices of new publications, with request to forward postage in case the report is desired. Special notices inquiring whether the person addressed desires to be retained on the list are also sent out from time to time.

The cost of printing and engraving is paid out of the State treasury and does not fall upon the Survey appropriation. The cost of printing, binding, and illustrating 17 of the reports ranged from $140 to $8,201. The size of these reports varied from 79 to 862 pages. The cost of printing during the last 35 years has averaged about $1,000 annually. The amount received from the sale of publications may aggregate $1,000. Part of this has been expended to meet Survey expenses and the remainder is in bank awaiting the decision of the attorney general as to its proper disposition

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

Investigations of the region of igneous and metamorphic rocks are in progress, and a map of the Coosa coal field is in preparation. From the outset the Survey has given consideration to all the natural resources of the State—mineral, geologic, agricultural, and biologic.

Data regarding the plants native to the State have been accumulat from the beginning of the Survey. Material has also gradually b collected for an account of the forms of animal life native to Alaba

Manuscripts awaiting publication include the third edition of t report on iron making in Alabama, a report on the timber trees other woody plants of Alabama, a report, with map, of the Cah coal field, and a bulletin on the road materials and highways of t State.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—The mapping of a part Fayette County, embracing the territory where gas wells have be brought in, is in progress in cooperation with the United Stat Geological Survey. Each Survey is to expend $1,000 on this wor A joint study of the deposits of the Alabama coastal plain is a being made. Statistics of the mineral production of Alabama a collected in cooperation with the Federal Survey.

Other departments of the National Government.—Statistics of t public highways of Alabama are collected in cooperation with United States Department of Agriculture. "The plant life of Alabama," by Dr. Charles Mohr, issued in 1901, was also published in cooperation with that department.

Other State geological surveys.—While no definite plans have been formulated for cooperation with other State surveys, a close correspondence is maintained with the State geologists of South Carolina, Georgia, Florida, and Mississippi, and from time to time joint trips are made with the heads of these surveys, with the view to coordination of work.

Other scientific bureaus of the State.—There is no active cooperation with other scientific bureaus of the State. Under the law duplicates of collections made in Alabama by the Geological Survey are deposited with the Alabama Polytechnic Institute and the State commissioner of agriculture and industries. Surplus duplicates in the collections are distributed among the most important high schools of the State, other State institutions, and scientific societies, with the view to building up branch museums in different parts of the State.

ARIZONA.

The office of Territorial geologist of Arizona has been held successively by John F. Blandy, Theodore B. Comstock, W. P. Blake (recently deceased), and C. F. Tolman. The office has been considered an honorary one, and in recent years no funds have been available for the work, although in 1909 a small apportionment for expenses was made.

The reports of the Territorial geologists have consisted of brief statements, published at irregular intervals, in the reports of the Governor to the Secretary of the Interior at Washington, D. C. Dr. Blake's latest report appeared under the title "Minerals of Arizona, their occurrence and association."

The forthcoming report of the Territorial geologist will contain a geologic map of Arizona, as well as a bibliography of Arizona geology and allied subjects. A summary of the salient features of the geology of Arizona's mineral deposits is also in preparation.

ARKANSAS.

PREVIOUS SURVEYS.

OWEN SURVEY.[a]

The subject of a State Geological Survey of Arkansas was first brought to public attention by Governor Elias N. Conway in his message to the legislature in 1856. On his recommendation the matter was taken into consideration, and the first Geological Survey of the State was begun under an act passed January 4, 1857. This act provided for the appointment of a State geologist by the governor, and an appropriation of $4,800 per annum, out of which all expenses were to be paid. Dr. David Dale Owen, then State geologist of Kentucky, was appointed State Geologist of Arkansas, and entered upon his duties October 1, 1857. The results of the work done in 1857 and 1858 are given in Owen's "First report of a geological reconnoissance of the northern counties of Arkansas," Little Rock, 1858.

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The bill providing for the continuation of the Survey passed in February, 1859; by its provisions the State geologist's salary was raised from $1,800 to $2,500, and an appropriation of $6,000 per annum was made for the Survey work. Under this act Dr. Owen was again appointed State geologist. Before the next legislature convened Dr. Owen died (November 13, 1860) and his "Second report of a geological reconnoissance" was edited by his brother, Dr. Richard Owen and Prof. J. P. Lesley, and was printed at Philadelphia in 1860.

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The civil war broke out shortly after the publication of Dr. Owen's second report, and all such work was necessarily suspended in the Southern States. No steps were taken to finish the geological survey of Arkansas until after the close of the war.

RECONSTRUCTION SURVEYS.[a]

In the general assembly of 1866 a bill was passed by the senate providing for a Geological Survey of the State, but it was rejected by the lower house.

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In the legislature of 1871 a survey bill was passed (and approved March 28, 1871) appropriating $15,000 for two years' work. Under this act Governor O. A. Hadley appointed W. F. Roberts, sr., of Pennsylvania, State geologist.

[a] Branner, J. C., Jour. Geology, vol. 2, No. 8, 1894, pp. 826–836.

The records in the office of the secretary of state do not show how long Mr. Roberts held office, but he was appointed June 5, 1871.

Dr. George Haddock, then of Arkadelphia, was, upon Governor Hadley's recommendation, appointed Mr. Roberts's assistant, and went with him through the western part of the State.

Mr. Roberts's report was never delivered to the governor. * * * A series of articles, however, was subsequently published by Mr. Roberts in the Age of Steel, of St. Louis, Mo. (1887–88), and it is probable that these articles represent his views of the geology of the State and give the results of his work. They are largely a repetition of the results given by Dr. Owen.

In 1873 Dr. George Haddock, who had been Mr. Roberts's assistant, published at Little Rock a pamphlet of 66 pages, entitled "Report of a geological reconnoissance of a part of the State of Arkansas made during the years 1871–72." This paper gives the only results of the work done under this appropriation. It is of but little or no importance and adds nothing to the work done by Dr. Owen.

The general assembly of 1873 passed a bill for the continuation of the survey, and made an appropriation of $15,000 for it.

Under this act the following State geologists were appointed: George Haddock, appointed May 15, 1873, removed from office January 14, 1874. Mr. Haddock * * * made no report except the one published under a former appropriation and mentioned above. William C. Hazeldine, appointed January 14, 1874, and removed June 29, 1874. * * * As State geologist he made no report, and, so far as can be ascertained, did no field work. Arnold Syberg was appointed June 29, 1874, and remained in office to the end of the term. * * * Mr. Syberg * * * made no report, and * * * the only work he did was to receive and examine specimens sent or brought in from various parts of the State.

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The failure of the surveys for years 1868 to 1875 to yield any geological results must be attributed to the general demoralization of the State government during the reconstruction period.

No further efforts were made to carry on a geological survey until the year 1881, when a bill for such work was defeated in both branches of the general assembly.

In the assembly of 1883 the only legislation passed relating to geological work was a senate concurrent resolution "authorizing and directing the governor to make application to the Secretary of the Interior of the United States for a geological survey of the State of Arkansas." Nothing seems to have come of this effort to obtain help from the National Government.

BRANNER SURVEY.

In January, 1887, Governor Simon P. Hughes, in his message to the general assembly, suggested an appropriation for a Geological Survey. An act was accordingly passed providing for the appointment of a State geologist and three assistants. Under this act Dr. J. C. Branner was appointed State geologist and entered upon the duties of the office June 24, 1887.

In the general assembly of 1889 there was much opposition to the continuance of the Survey, "due chiefly to the fact that the Survey had declared fraudulent certain so-called gold mines in the western

part of the State." The bill, however, passed, and Dr. Branner was reappointed State geologist. The Survey was continued by the general assembly of 1891, with the understanding that it should be brought to a close by the end of March, 1893. However, the general assembly of 1893 appropriated $4,000 to complete the publication of reports. During Dr. Branner's term of office a large number of reports were issued. The annual report for 1888 comprised four volumes, that of 1889 two volumes, 1891 two volumes, 1892 five volumes, and two reports remain unpublished for lack of appropriations. The reports issued are chiefly of an economic nature, although a few are of a more general geologic character.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the Geological Survey of Arkansas; it was established in 1907.

ORGANIZATION AND SUMMARY OF LAWS.

The Survey is in charge of a commission, known as the geological commission of Arkansas, and composed of the governor of the State, the president of the University of Arkansas, and the commissioner of mines, manufactures, and agriculture. The members of the commission receive no compensation for services rendered for the Survey, but are reimbursed for actually necessary expenses.

The title of the executive officer is State geologist of Arkansas. The professor of geology in the University of Arkansas is ex officio State geologist. The position is now filled by Prof. A. H. Purdue, who devotes about 15 per cent of his time to Survey work. The compensation, which is per diem, is fixed by the commission.

The assistants include one geologic aid, six engineering aids, and one clerk. The assistants are appointed by the State geologist, subject to the approval of the commission. To the present time they have all been professors or advanced students of the University of Arkansas.

APPROPRIATIONS.

Appropriations are made biennially and are partly contingent on cooperation with the United States Geological Survey. Unexpended balances carry to the next fiscal year.

The amount of the appropriation varies. The act of 1907 appropriated $1,800 "for a geological survey of the slate deposits in Arkansas in cooperation with the United States Geological Survey." The act of 1909 appropriated $5,000 for the purpose of carrying on

the work of the Survey. The money is expended in about the following proportions:

	Per cent.
Administrative and routine clerical work	14
Economic, stratigraphic, and areal geology, etc	16
Investigation of stream flow, etc	44
Other technologic work	16

Appropriations for the next biennial period have not yet been made, but as this bulletin goes to press it is learned that the senate of the general assembly has passed a bill with but one dissenting vote appropriating $7,500 for 1911–12.

PUBLICATIONS.

Three reports have been issued by the present Geological Survey of Arkansas. One is on the slates of the State, another is on coal mining in the State, and the third is a preliminary report on the water powers.

The average annual cost of printing reports and maps for the last four years has been $1,300. This is paid from the State printing fund.

The State geologist has full control of the printing, except the choice of printer. Printing is done by contract with the State printing board.

The State geologist has control of the distribution of the reports, except that by law each member of the legislature receives 10 copies. The mailing list is composed of State educational institutions and other educational institutions of prominence, State geologists, State geological surveys, geologists, and the leading libraries of the country.

PRESENT LINES OF WORK.

Independent field work.—An investigation of the clay deposits of the State is in progress, with the view of ascertaining the extent of each deposit and the purposes to which it is best suited, also an investigation of coal mining in the State, for the purpose of conserving the coal deposits and improving the coal-mining industry.

Cooperation with United States Geological Survey.—In cooperation with the Federal Survey the water powers of the State are being studied.

CALIFORNIA.

PREVIOUS SURVEYS.

The California State legislature in 1860 enacted a law providing for the appointment of a State geologist and appointed Prof. J. D. Whitney to the position. His duty, as set forth in the law, was defined as follows:

With the aid of such assistants as he may appoint, to make an accurate and complete geological survey of the State and to furnish in his report of the same

proper maps and diagrams thereof, with a full and scientific description of its rocks, fossils, soils, and minerals, and of its botanical and zoological productions, together with specimens of the same, which specimens shall be properly labeled and arranged and deposited in such place as shall be hereafter provided for that purpose by the legislature.

Prof. Whitney, as State geologist, appointed Prof. W. H. Brewer principal assisant in charge of the botanical department and William Ashburner assistant in geologic field work. The party assembled in San Francisco in November, 1860, and soon began field work. The first year of reconnoissance was devoted almost exclusively to the Coast Ranges, but subsequently other portions of the State were visited. Connected with the Survey originally were C. Averill and C. J. Hoffman, topographic assistants; Dr. J. G. Cooper, zoologist; W. M. Gabb, paleontologist; Prof. Brush, of the Sheffield Scientific School, who made an examination of ores; and Clarence King, a volunteer assistant in the reconnoissance of the high Sierra.

Four years later the California legislature enacted a law to continue the Survey and again appointed Prof. Whitney to the position of State geologist. In token of appreciation of the work performed the salary of the State geologist was increased from $6,000 to $9,000 per annum.

Several years later the legislature suspended the work of the Survey, but the publication of the reports of the State geologist and his assistants continued for a time. Among the volumes issued were "The Yosemite guide book," "Contributions to barometric hypsometry," "Report on the fossil plants of the auriferous gravel deposits of the Sierra Nevada," "The climatic changes of later geological times," "Detailed description of the Mount Diablo coal fields," "Examination of the bituminous substances occurring in southern California," "Report on an examination of the quicksilver mines of California," and "Chemical examination of Pacific coast coals."

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the California State Mining Bureau; it was established by an act approved April 16, 1880.

Under this act the following have served as State mineralogist: Henry G. Hanks, 1880 to 1886; Wm. Irelan, 1886 to 1893; J. J. Crawford, 1893 to 1897; A. S. Cooper, 1897 to 1901; L. E. Aubury, 1901 to the present time.

SUMMARY OF LAWS AND ORGANIZATION.

The law governing the Bureau provides—

(1) For the maintenance of a principal office in San Francisco, under the supervision of the board of trustees, numbering five, all of whom must be residents and citizens of the State.

(2) That the trustees shall hold office four years from the date of their appointment and shall have control of all properties and funds of the Bureau.

(3) That the governor shall appoint the State mineralogist, who must have a practical knowledge of mining and mineralogy and who shall hold office for the term of four years from the date of his appointment.

(4) That the duties of the State mineralogist shall include the collection of statistics regarding the economically important minerals; the making of a collection of typical geologic and mineralogical specimens to constitute the museum of the State Mining Bureau; the assembling of a library of books, reports, and drawings bearing upon the mineral industries, the sciences of mineralogy and geology; the collection of models, drawings, and descriptions of the appliances used in mining and metallurgical work; and the issuance of biennial reports, setting forth the important results of the work, and such bulletins as he may deem advisable concerning the statistics and technology of the mining industries of the State.

The trustees serve without salary; the State mineralogist receives a salary of $250 a month.

The present State mineralogist is L. E. Aubury. The employees of the State Mining Bureau include a secretary and curator of the museum, a geologist, a librarian, a statistician and assistants, clerical help, and field assistants. The number of the latter varies from time to time. All the subordinates are appointed by the State mineralogist. They are employed by the month. The salaries range from $85 to $150 a month.

APPROPRIATIONS.

Appropriations are made by the State legislature biennially. No appropriation is made contingent upon cooperation. Unexpended balances lapse to the State treasury about 60 days after the close of the fiscal year. There is no fixed appropriation; the amounts vary. The appropriations provide for salaries, field work, current expenses of the Bureau, and the maintenance of the museum, library, and geologic and statistical departments.

PUBLICATIONS.

The publications issued by the California State Mining Bureau number 58. They include the first and third biennial reports (numbered XI and XIII, respectively); a series of 18 bulletins; the register of mines, with maps, of 17 counties; the register of oil wells, with map, of one county; 10 maps showing boundaries of national forests; and 8 other special maps, of certain districts. Aside from

the maps, the publications are wholly of an economic character and relate entirely to the minerals of the State.

The size of the edition varies according to the estimated demand, but the average is about 2,500 copies.

The method of distribution is provided for by the following law:

The board [board of trustees] is hereby empowered to fix a price upon, and to dispose of to the public, at such prices, any and all publications of the Bureau, including reports, bulletins, maps, registers, etc. The sum derived from such disposition must be accounted for and used as a revolving printing and publishing fund for other reports, bulletins, maps, registers, etc. The prices fixed must approximate the actual cost of printing and issuing the respective reports, bulletins, maps, registers, etc., without reference to the cost of obtaining and preparing the information embraced therein.

All publications of the Bureau are issued from the press of the State printer at Sacramento.

The State mineralogist dictates the style, matter, paper, and contents of the publications. The Bureau distributes its own publications. Some of them are sold at a nominal price. Purely statistical works are distributed free at the office of the Bureau; when they are mailed postage is charged. The mailing list includes newspapers, magazines, and interested persons. The list is kept alive by exchanges; these include technical journals, the daily press, etc.

PRESENT LINES OF WORK.

General scope.—The California State Mining Bureau is, as its name implies, devoted primarily to the interests of the miners and the producers of minerals in California. Its principal lines of work consist of the preparation of publications dealing with both general and special investigations of the mining industry. In connection therewith it maintains, in a permanent museum, a large collection of minerals and mining appliances, also a library made up of mining and allied publications, maps, etc. It annually collects and disseminates, in a series of bulletins, mining statistics. It endeavors to prevent discrimination against the products of the State whenever public moneys are to be expended for the construction of buildings or other purposes.

Cooperation with United States Geological Survey.—The Bureau cooperates to a certain extent with the United States Geological Survey, from which statistics relating to the production of precious metals in California are received. These are made a part of the statistical reports issued by the State Mining Bureau, and due credit is given to the Federal Survey for its agency in the matter.

Other cooperative investigations.—Cooperation of the Bureau with technical or other societies is not obligatory, but the policy of the trustees is liberal in this direction, and assistance is often given.

COLORADO.

PREVIOUS SURVEYS.

The office of State geologist of Colorado was created by act of the Territorial legislature in 1872, under which the governor of the State was authorized "to appoint, by and with the advice of the senate, a State geologist * * * to hold office for a period of two years." This seems to show an early appreciation of the needs of the State; but another clause of the same act reads as follows: "No compensation for services, nor for any expense whatever, shall be paid by the State to or for said State geologist."

So far as the available records show, the first State geologist was J. Alden Smith, who was appointed in 1874. The law provided that the State geologist should hold office until his successor was appointed. This may account for certain irregularities in the dates of appointments. In 1881 Mr. Smith was again chosen. From that time until the organization of the State Geological Survey, in 1907, the appointments were as follows: 1883, Ernest Le Neve Foster, Georgetown; 1885, J. Alden Smith, Denver; 1887, Fred G. Buckley, Leadville; 1889, 1893, Geo. E. Kedzie, Ouray; 1897, 1899, Thomas A. Rickard, Denver; 1901, 1903, John W. Finch, Victor; 1906, B. A. Langridge, Boulder.

As will be seen by the above list, some very able men have filled the office of State geologist, but the failure of the State to provide funds for the work prevented them from accomplishing much. Three or four brief reports were published, but these were long since out of print.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the Colorado State Geological Survey; it was organized April 24, 1907, under a law of 1907, which was amended in 1909.

SUMMARY OF LAWS.

The law establishing the Survey, enacted in 1907, as amended in 1909, is as follows:

SECTION 1. There is hereby created and established a State Geological Survey, which shall be under the direction of an advisory board, composed of the governor of the State, who shall be ex officio chairman, the president of the University of Colorado, the president of the State School of Mines, and the president of the State Agricultural College. The advisory board shall confer with the State geologist in all matters pertaining to the aims and objects, and to the conduct of the work of the Survey. Said board shall receive no compensation, but the members shall be reimbursed for expenses actually incurred in the performance of their official duties.

SEC. 2. The said Survey shall have for its objects:

(1) A study of the geological formations of the State with special reference to its economic mineral resources, namely, the gold, silver, lead, copper, iron, and other metallic ores; the clays, coals, oil, gas, building materials, artesian and mineral waters, and other mineral substances.

(2) An examination of the topography and physical features of the State with reference to their practical bearing upon the occupations of the people.

(3) Such cooperation with the State Bureau of Mines as shall be mutually beneficial.

(4) The preparation and publication from time to time of geologic, economic maps to illustrate the mineral resources of the State.

(5) The preparation and publication of special reports, with necessary illustrations and maps, which shall give both the general and detailed description of the geology and natural resources of the State.

(6) The preparation and publication of a comprehensive summary or digest, together with a complete bibliography and maps, of all the trustworthy literature and reports heretofore published on the geology and mineral resources of Colorado.

(7) The preparation of a series of bulletins on the geology, geography, and natural resources of Colorado, suitable for use in the high schools of the State.

(8) The consideration of such other scientific and economic subjects and questions as in the judgment of the advisory board shall be deemed of value to the people of the State.

SEC. 3. The field investigation, preparation of reports and maps, and all the executive functions of the Survey shall be under the personal supervision of the head professor of geology in the University of Colorado, who shall also be State geologist of Colorado. He shall prepare and submit to the advisory board, not oftener than once each fiscal year ending June 30, a regular report of 450 octavo pages or less on the work of the Survey as defined in section 2 of this act. The various reports of the Survey shall be distributed, on application, to the people of the State, used in exchange, or sold to nonresidents, as in the belief of the advisory board may best serve the interests of the State. All moneys realized from the sale of said publications shall be paid into the treasury of the State as a part of the funds of this Survey.

SEC. 4. The State geologist may appoint, with the approval of the advisory board, such temporary assistants as may be required to carry out the provisions of this act, from the teachers of geology in the educational institutions of the State, or other persons fully competent to perform the particular work required of them.

SEC. 5. Specimens and all materials for illustration or study, collected in the work of the Survey, after they have served the purpose of the Survey, shall be placed on exhibition at the headquarters of the Survey as a permanent exhibit of the Survey, except that unnecessary duplicates and excess material shall be distributed by the State geologist to the educational institutions of the State, in such manner as the advisory board may direct.

SEC. 6. The State geologist, with the approval of the advisory board, is hereby authorized to cooperate with the Director of the United States Geological Survey, under the fixed rules of the latter institution, in the mapping and geological investigation of any area in the State of Colorado, and to direct the disbursement of the funds of this Survey to that end, providing that such disbursement shall never exceed one-half the expense of the particular cooperative work so undertaken.

SEC. 7. The reports of the State geologist shall be published in the manner that the reports of other State officers are published.

SEC. 8. The office and headquarters of the State Geological Survey shall be the department of geology at the University of Colorado.

SEC. 9. The salary of the State geologist shall be $500 per annum as remuneration for the proper performance of the executive work of the Survey. In addition to said salary he shall also be entitled to $10 per diem for Survey work other than that pertaining to the executive functions of this office, except that the number of days so employed shall not exceed in any year the number of days on which he is not acting as professor of geology at the University of Colorado. The assistants to the State geologist shall receive a remuneration not to exceed $10 per diem for such time as they are in the actual service of the Survey. The State geologist and his assistants shall also be reimbursed all necessary traveling and field expenses, providing the total of said expenses does not exceed for any person so employed $500 for any fiscal year.

SEC. 10. To carry out the provisions of this act the following sums be appropriated annually for the biennial period of 1909 and 1910, out of any money in the State treasury not otherwise appropriated: For the regular work of the State Geological Survey the sum of $10,000; and the auditor of the State treasury is hereby authorized to draw his warrants upon the State treasury in payment of the moneys hereby appropriated upon certified vouchers of the State geologist. The appropriation for cooperation with the United States Geological Survey shall be conditioned upon the United States Government spending an equal amount in the said cooperative work.

SEC. 11. The State geologist and his assistants shall take the usual oath of office to perform all the services required of them under this act, and to guard as confidential all information accumulated in the progress of their work; to refrain from any pecuniary speculation based upon any knowledge of a commercial or economic nature acquired in the pursuit of their duties, until said knowledge or information shall have been fully published and submitted to the people of the State; and to turn over to the Survey as State property, all correspondence, notes, illustrations, and data of every kind accumulated by them in connection with the work of the Survey.

SEC. 12. All acts and part acts in conflict herewith are hereby repealed.

SEC. 13. In the opinion of the general assembly of the State of Colorado an emergency exists, and therefore this act should take effect and be in force from and after its passage.

Approved, April 24, 1907.

ORGANIZATION.

The form of organization of the Survey is fully defined in the law quoted above. The present personnel is as follows: Prof. R. D. George, University of Colorado, State geologist; Prof. H. B. Patton, Colorado School of Mines, Dr. James Underhill, mining engineer, Idaho Springs, Prof. G. M. Butler, Colorado School of Mines, Prof. R. D. Crawford, University of Colorado, and Prof. C. E. Smith, Colorado School of Mines, geologists; Prof. Junius Henderson, University of Colorado, paleontologist; Prof. J. B. Ekeley, University of Colorado, and Harmon Tremain, chemists; Prof. F. F. Grout, University of Minnesota, clay investigation; H. C. Woods, instructor in University of Colorado, and E. M. Kayden, draftsmen; P. G. Worcester, instructor in University of Colorado, topographer; R. M. Butters and David L. Curtis, field assistants in paleontology; G. B. Warner, R. S.

Coffin, assistants in geology; D. A. Worcester, H. W. Thurston. field assistants; G. W. Voelzel, A. F. Mertes, R. G. Bowman, C. D. Heaton, and A. W. Lauer, assistants on clay investigation.

The average cost of field work has been $5 a day and expenses. Advanced students serve for field expenses only.

APPROPRIATIONS.

The Survey appropriations are made biennially, and unexpended balances lapse to the State treasury immediately at the end of the biennium. The sum of $5,000 per annum was appropriated for 1907 and 1908 and $10,000 per annum for 1909 and 1910.

The current appropriation is expended as follows:

	Per cent.
Administrative work	10
Topographic work	25
Economic, stratigraphic, and areal geology	50
Paleontologic work	2
Chemical work	5
Collection of rocks and minerals of State for high schools of the State	8

PUBLICATIONS.

The publications of the Survey consist of annual reports and bulletins. There have been issued one annual report and two bulletins. The report contains papers on the main tungsten area of Boulder County, on the Montezuma mining district, on the foothills formations of north-central Colorado, and on the Hahns Peak region. Bulletin 1 is devoted to a preliminary report on the geology of the Monarch mining district, and Bulletin 2 to the Gray Back mining district.

The publications are distributed free. The cost of printing is borne by the State and is not known to the Survey. The printing is done by State printers, but the State geologist has almost complete control over it, and he has entire control over the distribution of publications.

The mailing list includes the principal colleges and public and school libraries of the State. Publications are also sent to interested persons. The mailing list is kept alive by means of card receipts.

PRESENT LINES OF WORK.

The work of the Survey completed and in progress may be summarized as follows:

Field work.—(1) An area of 110 square miles about Hahns Peak, Routt County, has been mapped on a scale of 1 mile to the inch. (2) The Boulder County tungsten field, 90 square miles, has been

mapped on a scale of 1 mile to the inch. (3) The sedimentary formations flanking the foothills have been studied and mapped from the Wyoming line southward for 75 miles, to connect with detailed work done by the United States Geological Survey farther south and complete the strip across the State. This work was done to determine the age of the formations preparatory to publishing the geologic map, and as a basis for a study of the economic deposits. such as clays, cement materials, and building stones. (4) The Montezuma area, in Summit County, 22 square miles, has been mapped in detail, both topographically and geologically.

Analyses, assays, and determinations.—In connection with the field work of the Survey about 50 complete chemical analyses and assays and more than 100 other determinations have been made. The State Survey will not do work which should go to private chemists and assayers, but only that demanded by its own reports.

Topographic map.—The Hayden Survey of the Territories, completed in 1878, made a topographic map of about two-thirds of the State. The King Survey of the fortieth parallel mapped a narrow strip about two-thirds of the way across the northern boundary of the State. Of the area not covered by these two surveys, over one-half has been mapped in detail by the present United States Geological Survey. The other half has been mapped in less detail. The present United States Geological Survey has also mapped in greater detail a considerable portion of the area covered by the earlier surveys. The maps of the earlier surveys are available to only a very small number of people, and those of the present surveys are contained in about 60 separate sheets. The State Geological Survey has therefore compiled a topographic map of the State, on a scale of 8 miles to the inch, combining, so far as the scale would permit, the results of these surveys and including all the geographic details usually found in a complete State map. This map will be used as a base for the revised geologic map and for maps showing the various mineral deposits, water resources, and other economic features of the State. It is almost ready for the engraver, but the State Survey is waiting to incorporate in it the results of the latest work of the United States Geological Survey, which will be supplied as soon as proofs can be made. This map should be in every school and every home in the State.

Geologic map.—The only geologic map covering the State is a small one, on a scale of 12 miles to the inch, published by the Hayden Survey in 1876 and 1881. This is very general and very incomplete. The later Hayden atlas covers only two-thirds of the State. A vast amount of detailed geologic work has been done in Colorado during the last 30 years, which has modified in many important ways the conclusions reached by the Hayden geologists in their hurried survey.

The results of the later work are published in perhaps 40 separate maps, many of which are not easily available. The State Geological Survey is therefore compiling a map, on the same scale as the topographic map, which shall bring together, so far as the scale will permit, the results of all geologic work done in the State up to the present time. The drafting is probably three-fourths done, and the explanatory sketch of the geology, to accompany the map, is well advanced.

Special maps.—A map showing the metalliferous deposits of the State is approaching completion; another showing the location of the coal fields is ready for the draftsman.

Bibliography of the geologic literature of Colorado.—This work is well advanced and already contains over 5,000 classified entries, together with reference letters indicating the important libraries of the State in which the book, article, or report may be found.

Other reports commenced.—Other reports in course of preparation include one on the distribution, qualities, and value of the clays of the State (Prof. G. M. Butler, School of Mines); one on the building stones and marbles of Colorado (R. D. George and A. P. Poorman); one on cement materials, limestone, and gypsum (direction of R. D. George); and one on the descriptive geology of the State, which will be published in two bulletins, one relating to the general geology and the other to the economic geology (R. D. George and Prof. Crawford).

Cooperation with the United States Geological Survey.—The Federal Survey offers to cooperate with the State Survey in topographic mapping on the following terms: The State to pay one-half and the Federal Government to pay one-half; the choice of the areas to be mapped to be left to the State. These terms are very liberal, and there is no State in the Union to which a complete and detailed topographic map would be of greater service than to Colorado. It is a prime necessity in the development of the water resources of the State, both for power and irrigation, and it is needed in railway construction, in the development of the mineral resources, and in many other ways.

CONNECTICUT.

PREVIOUS SURVEYS.

The first geologic survey of Connecticut was started as the result of a recommendation by Governor Edwards in his annual message to the legislature in 1835. The legislature acted upon this recommendation by passing a resolution "that the governor be, and is hereby, authorized to appoint a committee of suitable persons to make a geological survey of the State of Connecticut." After considerable persuasion, James Gates Percival and Charles Upham Shep-

ard were induced to serve as the committee called for by this resolution. It was agreed that Percival should undertake the study of the general geology of the State and Shepard the study of the mineralogy and economic geology. Shepard's report was dated May 15, 1837, and by order of the legislature 2,000 copies of it were printed. The task which Percival had undertaken was more extended and difficult. In the spring of 1838 he presented a manuscript report but considered the work so incomplete that he was unwilling to have the report printed. Year after year he labored, on a very small appropriation, while the State authorities became more and more impatient for the publication of some definite results. Finally, in 1842, an edition of 1,000 copies of his "Report on the geology of the State of Connecticut" was printed. This report is merely a description of the local distribution of several geologic formations, designated in the text and on the map by an elaborate notation of Roman letters, Greek letters, and punctuation marks. But students of Connecticut geology, in the three score and more years which have elapsed since the publication of Percival's book, have regarded it with admiration for the conscientious thoroughness with which the study of the areal geology of the State was accomplished.

The only other work at all in the nature of a geologic survey, which was done under the auspices of the State of Connecticut before the organization of the present Survey, was the topographic survey for which provision was made by act of the legislature in 1889. According to this act a commission was appointed by the governor "to confer with the Director or representative of the United States Geological Survey, and to accept its cooperation" in the preparation of a topographic map of the State. The State appropriated a sum not exceeding $25,000, on condition that an equal amount should be expended by the United States Geological Survey. The amount actually expended was a few hundred dollars less than the maximum specified in the resolution. The commissioners appointed to represent the State were William H. Brewer, James H. Chapin, and John W. Bacon. The work was begun in July, 1889, and was completed in 1893.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is designated the State Geological and Natural History Survey; it was organized under an act approved June 3, 1903.

SUMMARY OF LAWS.

The law under which the Survey operates provides for a commission, composed of the governor of the State and the presidents of Yale University, Wesleyan University, Trinity College, and the

Connecticut Agricultural College. The commissioners serve without compensation, but are entitled to reimbursement for actual expenses incurred. They have power to appoint a superintendent and such other employees as they may deem necessary and to fix the rate of compensation to be paid them. All appointees are subject to removal at the pleasure of the commissioners.

The Survey is directed to study the geologic formations and the animal and plant life of the State, also to give special attention to economic products and to render such service as it can to the educational institutions of the State. Material collected by the Survey may, at the discretion of the commissioners, be distributed to educational institutions of the State or be retained for exhibition purposes.

The law provides that biennially a report of the progress and condition of the Survey shall be submitted to the legislature, and also that special reports on subjects investigated, accompanied by proper illustrations and maps, may from time to time be published.

ORGANIZATION.

Soon after the passage of the act just described, William North Rice was appointed superintendent of the Survey, and he has continued to hold office until the present time. The tenure of office of the superintendent is at the discretion of the commissioners. His salary, which is fixed by the commissioners, is $200 a year, with an annual allowance of $150 for traveling and other expenses. The salary is paid in quarterly installments. Bills for expenses are presented to the State comptroller. In view of the small salary the superintendent is not expected to give a large part of his time to the work of the Survey. The present superintendent is professor of geology in Wesleyan University and receives the full salary of a professor in that institution. His time is therefore devoted chiefly to college work.

Since the organization of the Survey no other salaried officers have been appointed. Scientific men have, from time to time, been engaged for special investigations, with the understanding that on the completion of the investigation a report would be submitted which, if accepted by the superintendent, would be published as a bulletin of the Survey. Most of the contracts made with scientific men have specified the payment of a certain sum on the completion of the work and the acceptance of the manuscript by the superintendent. An allowance for expenses, to be drawn upon as occasion required, has also been made to them. This allowance covers traveling expenses, clerical assistance, and the employment of students or others for the working out of details required by the scientific investigator.

In cases where it was impossible to make a definite estimate regarding the amount of work involved in an investigation, the contract with the scientific man has provided for the payment of a certain sum per diem for time employed in field or laboratory work. In these cases, however, a maximum sum for the investigation has been specified. Other contracts have provided for a per diem compensation for field work, and in addition the payment of a specified sum upon the completion of the manuscript and its acceptance by the superintendent.

All contracts with scientific men are subject to the approval of the commissioners. These men, like the superintendent, have performed their work for a nominal compensation—a few of them for no compensation—and have therefore devoted to it only the time they could spare from other professional duties. Most of them have been professors or instructors in colleges; some have been graduate students. The investigation assigned to a man has usually been one which he had already undertaken because of its congeniality.

APPROPRIATIONS.

Appropriations are made by the legislature at each biennial session. The Survey has not yet been granted continuing appropriations. Each appropriation is good for two years and unexpended balances lapse into the State treasury. It is, however, the rule of the comptroller's office that for a period of six months after the expiration of the biennial term an appropriation may be drawn upon to satisfy contracts made before the expiration of the biennial period.

The appropriation is $3,000 for each biennial term. This amount is to cover all salaries and expenses of the Survey except the cost of printing and engraving. The appropriation is expended under the direction of the commissioners. As the Survey is designed to cover the geology, zoology, and botany of the State the endeavor has been to divide the appropriation about equally between geology and biology. It has been disbursed in about the following proportions:

	Per cent.
Administration	22
Geology, including economic geology	36
Paleontology	5
Botany and zoology	37

PUBLICATIONS.

The publications of the State Geological and Natural History Survey of Connecticut number 17. Of these four are biennial reports, five relate to geology, and the remainder to biology. The geologic publications comprise a report on the clays and clay industries of the State, a manual of the geology of Connecticut, a preliminary

geologic map of the State, a bibliography of Connecticut geology, and a report on the lithology of the State.

The law provides for the publication of a biennial report of the progress of the Survey and for the publication of special reports from time to time. The size of the editions has varied from 3,000 to 4,000 copies, according to the estimated demand. The bulletins are distributed by the State librarian in accordance with regulations adopted by the commissioners. The mailing list includes the United States Geological Survey, State geological surveys, colleges, scientific schools and societies, academies and high schools within the State, scientific journals, the newspapers of the State, and to a limited extent the newspapers of adjacent States; also botanists, zoologists, and geologists. On application, teachers, advanced students, and citizens of the State are, whenever possible, supplied with bulletins on subjects in which they are specially interested. Although the commissioners have adopted a very liberal policy in the distribution of Survey publications, a price is fixed on each bulletin and they are sold to persons who have no special claim to receive them gratuitously. The income from sales is, however, insignificant. It goes into the State treasury.

The total cost of printing from the organization of the Survey in 1903 to April 1, 1910, was $12,582. Under the law establishing the Survey it was the intention that the cost of its publications should come out of the general appropriation for the printing of public documents. This intention, however, has been frustrated by an unfortunate oversight. A general law of the State limits the number of copies of any public document to 1,575 (with the exception of certain specified classes of documents) and provides for the distribution of a large part of the edition to State, county, and town officers. If the Survey bulletins were limited to the number prescribed by this general law, and if they were distributed in the manner indicated, the result would be that they would not reach the institutions and people who could use them. Special legislation was therefore necessary to authorize the printing of larger editions of Survey bulletins, and this was accompanied by the specification of a limit for the expenditure. The legislatures of 1907 and 1909 limited the biennial appropriations for Survey printing to $5,000.

The printing is done under the supervision of the State comptroller. The paper, size of page, and general typographic style are the same as in other public documents. Special contracts for maps and illustrations are made with the approval of the comptroller. The printing of each bulletin must be formally sanctioned by the board of control, which is composed of the governor, State treasurer, comptroller, and attorney general.

PRESENT LINES OF WORK.

Geology.—At present the geologic investigations relate chiefly to Quaternary geology, the following bulletins being in course of preparation: One on the Quaternary geology of the Naugatuck Valley, by Prof. H. E. Gregory; one on the glacial geology of the New Haven region, by Dr. Freeman Ward; and one on the terraces of the Thames, by Dr. F. P. Gulliver. There is also in contemplation a general paper on the Quaternary of Connecticut, to be illustrated by a map. A bulletin on the peat deposits of Connecticut, by Prof. C. A. Davis, will soon be published. This bulletin will treat of the purely scientific as well as the economic aspects of the subject.

Paleontology.—Two paleontologic papers are under way, one on Triassic fishes, by Dr. C. R. Eastman, and the other on the footprints of the Triassic sandstones, by Prof. R. S. Lull.

Biology.—Bulletins on certain groups of insects are in course of preparation, also on echinoderms and Crustacea of the Connecticut coast and on the birds of the State.

Cooperation with United States Geological Survey.—There has been no cooperation between the United States Geological Survey and the present State Survey, except in connection with the peat investigation, the only cooperation with the Federal organization on any extensive scale having been in connection with the topographic survey of the State, which was completed before the organization of the present Survey. Negotiations are in progress looking toward cooperation in an investigation of the water resources of the State.

FLORIDA.

PREVIOUS SURVEYS.

Before the organization of the present Geological Survey of Florida only a very small amount of geologic investigation had been conducted by the State. In 1853 the general assembly of Florida passed an act establishing the office of State engineer and geologist. The geologic part of the work, however, seems not to have been provided for. The first report of the State engineer and geologist comprises pages 19 to 36 of "Documents accompanying the message of the governor of Florida," submitted November 28, 1854. That part of the report relating to geology occurs on page 20 of the appendix and reads as follows:

> On the subject of the geology of the State, I have made no report, from the fact that the general assembly failed to specify any appropriations to defray any expenses incurred in reference to the matter. Consequently nothing has been done by me, except to obtain specimens of soils and minerals from the various localities (where marked changes were perceptible), visited by me in the performance of the duties of engineer.

The office of State engineer and geologist was abolished by an act of the legislative assembly of 1855.

In 1886 Governor Perry appointed Dr. J. Kost State geologist of Florida. This appointment seems to have been made with the expectation that a continuance of the geological survey would be provided for by the legislative assembly of the following year. This expectation, however, was not realized. During his temporary service as State geologist Dr. Kost traveled somewhat extensively in the State, and early in 1887 published a preliminary report entitled "First report of the geological survey of Florida." This report contains observations on the geology, physical geography, soils, and timber of the State, with remarks on the phosphates, lime, marls, clays, iron, coal, building stone, and mineral waters.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the Florida State Geological Survey; it was organized in June, 1907.

SUMMARY OF LAWS AND ORGANIZATION.

The law under which the Survey is established provides for the appointment by the governor of a State geologist, and for the appointment by the State geologist, subject to the approval of the governor, of such assistants as may be necessary to conduct the survey successfully and with reasonable dispatch, the assistants to be entirely under the control of the State geologist.

The State geologist is required to annually make to the governor a report of the progress of his surveys and explorations. In case of the discovery of mineral deposits or other substance of value the State geologist is required to notify the owner of the land upon which such deposits occur before disclosing the fact to any other person or persons.

Provision is made for the collection of specimens illustrating the geologic and mineral features of the State. One suite of the specimens is to be deposited in the office of the State geologist, and duplicate suites are to be sent to the State colleges.

The title of the executive officer is State geologist. The present incumbent, E. H. Sellards, was appointed June 19, 1907. The term of office of the State geologist is not specifically mentioned in the law establishing the Survey, but his salary is fixed at $2,500 per annum. All other expenses are paid by the comptroller, upon the requisition of the State geologist, approved by the governor. The assistants at present include one clerk and two assistant geologists. The chemical analyses required by the Survey are made by the State chemist.

APPROPRIATIONS.

The appropriations are continuing and are not contingent upon cooperation. Unexpended balances carry to the next fiscal year. The annual appropriation is $7,500. The objects of expenditure, within the general purposes of the Survey, are not fixed by law. The expenditures are distributed approximately as follows:

	Per cent.
Administrative work	13½
Economic geology	46½
Road materials	6½
Underground waters	36½

PUBLICATIONS.

The publications include annual reports, bulletins, and circulars. Two annual reports, one bulletin, and two circulars have been issued. The edition is 2,500 to 5,000 copies. All reports are distributed free.

The average annual cost of printing and engraving is $1,500. This is paid from the regular Survey appropriation.

At present, within the limit of the funds available, there are no limitations in choice of printer or style of report. The reports are distributed by the Survey. The mailing list includes standard libraries and all persons or firms requesting reports.

PRESENT LINES OF WORK.

Independent investigations.—The phosphate deposits of the State constitute the principal investigation at present.

Cooperation with United States Geological Survey.—In cooperation with the Federal Survey investigations are being made of the peat deposits and the water supplies of the State.

Cooperation with other scientific bureaus.—In cooperation with the department of civil engineering of the Florida State University the road materials of the State are being studied.

GEORGIA.

PREVIOUS SURVEYS.

The first effective effort toward the establishment of a Geological Survey of Georgia had its beginning in Governor Schley's message to the general assembly in 1836. The governor, in discussing the internal improvement of the State, wrote as follows:

Intimately connected with this subject is that of the geological structure of the State and of its mineral resources. A proper knowledge of these is necessary to a prudent and profitable location of canals and railroads and should have its influence in directing their course. Thus far, Georgia has scarcely

looked beneath her surface, and her great staple commodity has been the only article of transportation within the contemplation of those who have projected schemes of internal improvement, whilst the advantage to be derived from geological investigation has been entirely overlooked. In such a survey the whole State is interested, not merely in the increased variety of its products, but in the promotion of the most efficient culture by disclosing the character and capacity of the soil. Her territory, particularly that part comprehended within the Cherokee circuit, is believed to abound in mines of gold, marble, iron, limestone, salt, and other valuable minerals. These concealed treasures, which should be made tributary to her knowledge and wealth, are worthy of your enlightened consideration, and the provision necessary to a full and scientific examination of them ought not to be longer delayed. I suggest, therefore, the propriety of employing a competent geologist to make a thorough survey of the State, with a view to the ascertainment of its mineral and agricultural resources and the proper location of works of internal improvement.

Governor Schley supplemented the foregoing recommendation by the following note:

Since the above was written, I have received from Mr. John R. Cotting a letter dated at Augusta on the 15th ultimo, accompanied by a report of a geological and agricultural examination made by him, during the past summer, of the counties of Burke and Richmond. This survey was executed at the expense of individuals of these counties and is highly creditable to their public spirit and, as far as I can judge, equally so to the skill and capacity of Mr. Cotting as a scientific and practical geologist. I avail myself with pleasure of the opportunity thus afforded me of sending to the house of representatives this letter and report, with the hope that they may add force to the recommendation I have submitted.

Acting upon the recommendation of the governor, a committee was appointed by the legislature to consider the propriety of establishing a Geological Survey. This committee made the following report to the general assembly on November 26, 1836:

Resolved, That his excellency the governor be, and he is hereby, authorized to employ as soon as practicable one or more suitable and qualified persons to undertake the work of a careful and scientific survey of all the counties in this State, under his instructions and advice.

Be it further resolved, That the sum of $10,000 be appropriated for that purpose, subject to the warrant of the executive out of any moneys in the treasury, not otherwise appropriated, and the same be inserted in the appropriation act of this session of the general assembly.

The report above referred to by Governor Schley, on the counties of Burke and Richmond, paid for by the citizens of those counties, was a small volume of 189 pages, bearing the date of 1836. This report was devoted chiefly to the economic geology of the crystalline and Tertiary formations of Burke and Richmond Counties and formed a part of the annual report of Prof. John R. Cotting, State geologist, for the year 1837.

Under the resolution above referred to, Gov. Schley appointed John R. Cotting State geologist. His first annual report to the general assembly was made in 1837. It covered, more or less completely,

the counties of Chatham, Columbia, Effingham, Screven, Burke, Richmond, Lincoln, Elbert, Franklin, Habersham, and parts of Wilkes and Oglethorpe. The special committee, to which this report was referred, reviewed it in considerable detail, pointing out the important discoveries made in the location of valuable marl and graphite deposits, and also referring to important work done in establishing the variations of the magnetic needle at 20 different points in the counties in which work had been carried on. In addition to those investigations, the report stated that considerable time had been devoted to the study of the flora of the counties surveyed, about 1,200 specimens of plants having been collected. The committee recommended that the report of the State geologist be published and that copies of the tables of magnetic variation be sent to the clerks of the inferior courts of the several counties surveyed, where they were to be preserved for the benefit of county surveyors and others interested. For some reason, not given in the house journal, this recommendation was not favorably acted upon by the general assembly, and as a consequence the State geologist's report for 1837 was never published.

As the house journal for the year 1838 has apparently been lost, nothing is known of the action of the general assembly in regard to the Geological Survey until 1839, when a resolution was introduced in the house asking that the Geological Survey be abolished, on the ground that it had spent all of the $10,000 appropriated to carry on the work without any benefit whatever to the citizens of the State. This resolution was adopted by the general assembly in 1840, and the Survey was accordingly discontinued.

Efforts to reestablish the Survey were unsuccessful until 1874, when an act was passed by the general assembly appropriating $10,000 annually for a term of five years for the purpose of making a "geological, mineralogical, and physical survey" of the State. This act was similar to the act under which the present Survey operates. It was approved February 27, 1874, and in August Dr. George Little was appointed State geologist by the governor. During Dr. Little's term of office he made two annual reports of progress, one of 36 pages, covering the period from September 1 to December 31, 1874, and the other of 16 pages, bearing date 1876. In addition to these two reports of progress, Dr. Little in 1876 published (in the "Handbook of Georgia," issued by the State Agricultural Department) a paper of 126 pages treating of the geology, mineralogy, climate, water powers, soils, etc., of the State. These publications, together with a 16-page catalogue of ores, rocks, and woods selected for the Paris Exposition, are apparently the only ones issued by the Survey.

Between the date of the abolishment of this Survey in 1879 and its revival in 1889, a limited amount of geologic work was done by the

State Department of Agriculture, the results of which were published in the volume "Commonwealth of Georgia," bearing the date 1885.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present Survey is entitled the Geological Survey of Georgia; it was organized in 1889.

HISTORICAL SKETCH.

The present Survey began its work in July, 1890, with Dr. J. W. Spencer as State geologist. The law under which the Survey began operations was practically the same as that now in force. Dr. Spencer remained in office until 1893. During his incumbency two reports were published, one termed an administrative report, bearing date July 1, 1891, and the other entitled "The Paleozoic group—Geology of ten counties of northwest Georgia and resources." The former report, devoted largely to the Cretaceous and Tertiary formations of the coastal plain, contained 144 pages; the latter contained 406 pages and a geologic map of northwestern Georgia.

Prof. W. S. Yeates was appointed State geologist in July, 1893, and continued in office until his death, which occurred February 18, 1908, when S. W. McCallie, the present incumbent, was appointed.

SUMMARY OF LAWS.

The law under which the Survey operates is as follows:

State geologist.—The governor shall appoint, with the consent of the advisory board, a competent person as State geologist, who shall have a thorough scientific and practical knowledge of the science of geology and mineralogy and who is not connected with any school or college as an instructor. The State geologist shall enter upon the duties of his office on the 1st of July, 1899, and shall hold until removed by the appointing power for inefficiency, incompetency, or misconduct, or until the office is abolished by the general assembly. The office of the State geologist shall be at the seat of government.

Advisory board.—There shall be an advisory board, consisting of the governor of the State (who shall be president of the board), the commissioner of agriculture, the State school commissioner, the State treasurer, the comptroller general, the secretary of state, and the attorney general. Four members present at any meeting shall constitute a quorum for the transaction of any business.

Duty of geologist.—It shall be the duty of the State geologist to give his attention to the administration of the affairs of the Survey; to visit all parts of the State, so as to make himself familiar with the needs of each section; to supervise the work of his assistants, including all reports submitted by them for publication; to undertake such field work as his time will permit; and to perform such other duties as properly pertain to his office.

Assistant State geologists.—Two competent assistant State geologists shall be chosen by the State geologist, who may remove them at any time for incompetency, inefficiency, or misconduct. As soon as a general outline of a geological survey of the entire State shall have been made, the State geologist shall divide up the work between himself and his assistants in such way as shall be to the State's best interest, and under his direction and control the corps shall proceed to make a careful and complete geological, mineralogical, and physical survey of the State; to enter upon record, to be kept for that purpose in his office, an accurate statement of the extent of all water powers, roads, springs, and watercourses, and the climate, topography, and general physical character of the country, and locate the belts of ores, useful minerals, and building materials; to report characteristics and composition of soils and the deposits of marls and phosphates; to collect, analyze, and classify specimens of minerals, rocks, ores, fossils, and soils and enter the same on record; to cause to be preserved in a museum specimens illustrating the geology, mineralogy, soils, and whatever else may be discovered in the mineral or geological resources of Georgia having scientific or economic value; and he shall make a report of the survey of every county of this State, accompanied with all necessary maps and illustrations.

Survey of watercourses, lakes, etc.—It shall also be the duty of said State geologist to make a survey of the watercourses, ponds, lakes, and swamp region of Georgia, and submit, in the report provided for, a topographical map showing the location, extent, means, and plans of drainage, and also an estimate of the cost of said drainage of the ponds, lakes, and swamps of Georgia. The said State geologist shall also make an estimate of the value and extent of the lands to be reclaimed by said drainage.

Employment of topographers and drivers.—The State geologist is hereby authorized to employ two competent topographers and four assistant topographers and two drivers, as may be necessary to carry out the purpose of this chapter.

State geologist to supervise.—The State geologist shall have supervision of the entire work of the Survey, and shall be responsible for the accuracy of the same. It shall be the duty of the State geologist to make report to the advisory board once every three months—to wit, on the second Wednesdays in March, June, September, and December of each year.

No special surveys.—No individual, firm, or corporation shall have the right to call upon or require the State geologist to enter upon any special survey for his or their special benefit; but the Survey is to proceed upon a settled plan for the benefit of the public and investors and developers in general.

Supervision of expenses by board.—The advisory board shall have the supervision of the money expenditures in the prosecution of the work contemplated. The State geologist shall make to the advisory board monthly statements under oath of all incidental expenses necessarily incurred by himself and his assistants, accompanied by proper vouchers, in the discharge of their labors. The board shall audit such accounts, item by item, and approve or reject the same, as in their judgment may be right. When an account is allowed the governor shall draw his warrant for the amount thereof. The governor, with the advice and consent of the board, may at any time suspend the field operations.

His salary.—The salary of the State geologist shall be $2,500 per annum, and each assistant shall receive such salary per annum as shall be determined by the advisory board of the Geological Survey on the recommendation of the State geologist: *Provided*, That each assistant shall not receive more than $1,500 per annum.

Specialist.—The State geologist, with the consent of the board of advisement, may employ a specialist or specialists at any time.

When results of surveys may be published.—Neither the State geologist nor his assistants shall disclose to any person, except to the owner of the land, the result of a survey until the same is made public by publication of the report by the advisory board.

Maps of surveys State property.—The State geologist and his assistants shall deposit in the office of the governor all maps, surveys, notes, or memorandum of surveys when the surveys are completed, which are hereby declared to be the property of the State.

ORGANIZATION.

Details regarding the organization of the Survey are given under "Summary of laws." The executive officer is the State geologist. The present incumbent is Prof. S. W. McCallie.

APPROPRIATIONS.

Appropriations are made biennially and are not contingent upon cooperation with the United States Geological Survey. Unexpended balances lapse into the State treasury in the July following the year for which the appropriation is made. The amount of the appropriation is $10,000 per annum for the maintenance of the Survey and $2,500 per annum for printing. The manner in which the appropriations are to be expended is covered in a general way by the law organizing the Survey. Heretofore the energy of the Survey has been devoted largely to economic problems, though considerable work has been accomplished on the stratigraphic and areal geology of the State, as well as on the water resources and highway improvements.

PUBLICATIONS.

The publications of the present Survey comprise the 1891 administrative report of Dr. Spencer and his "Paleozoic group," also a series of bulletins, numbered from 1 to 24, inclusive. The bulletins pertain chiefly to the economic geology of the State, but two are devoted to the water powers of Georgia, two to the underground waters of the State, and two to roads and road-building materials.

The State geologist has control of the printing of reports, maps, etc. The size of the edition is 3,000 copies, 1,500 of which are bound in cloth and 1,500 with paper cover. The reports are sent to any applicant on receipt of postage. In addition, copies are mailed to all the leading papers and colleges of the State, to all State geological surveys, to many libraries in this country, and to some foreign libraries.

ILLINOIS.

PREVIOUS SURVEY.

The first Geological Survey of Illinois was created by the general assembly in 1851. It was placed in charge of a geologist appointed by the governor, auditor, and treasurer. The duties of the geologist were, briefly, "to ascertain the order, successive arrangement, relative position, dip, and comparative magnitude of the several strata or geological formations in the State, and to search for and examine all the beds and deposits of ores, coal, clays, marls, rocks, and such other mineral substances as may present themselves; to obtain chemical analyses of the same, and to determine by barometrical observations the relative elevation of the different portions of the State." He was also required to transmit an annual report, accompanied by necessary illustrations, for printing and distributing in such manner as the governor might indicate. Provision was also made for the collection of a cabinet of specimens found within the State, from which duplicates were to be distributed to the larger institutions of learning. The act provided a continuing annual appropriation of $3,000. This, however, was increased by the next legislature to $5,000 for general expenses and $500 per annum for topographic maps of the counties.

Dr. J. C. Norwood was in charge of the Survey for the first six years after its organization. He began work with an examination of the bluffs of Ohio River in southern Illinois. In six years about $27,000 had been expended, but no report had been submitted. An investigating committee found that the money had been wisely spent and recommended an additional appropriation for the completion of the work. Norwood's only publication, bearing the date of 1857, was a small octavo pamphlet of less than 100 pages devoted to the discussion of Illinois coals. It was accompanied by a one-page colored map of the State.

In 1858 Norwood turned over to his successor, Dr. A. H. Worthen, the field notes of several assistants and a report on the lead mines in Hardin County. The first report submitted by Worthen was devoted to two geologic sections, one across the Silurian and Devonian formations of southern Illinois, and the other following Mississippi River from end to end of the State. This report and the others submitted previous to 1865 were never published, owing to the opposition of certain members of the legislature. Indeed, an attempt was made to repeal the law under which the Survey was organized, and only the interference of the executive veto saved the organization.

Worthen reorganized the Survey and obtained the services of a number of specialists. J. D. Whitney was authorized to investigate the lead and zinc region of northwestern Illinois, and Prof. Leo

Lesquereux was engaged to investigate the "Coal Measures" and the Carboniferous plants. The assistance of F. B. Meek in the investigation of invertebrate fossils, and of Dr. J. S. Newberry in the department of vertebrate paleontology was also secured. The chemistry of the Survey was placed in the hands of a specialist, and the following other scientists shared the work of the first Survey: Engelmann, Prout, Bannister, Freeman, Scudder, Bradley, Green, Shaw, Broadhead, Cox, St. John, Miller, Wachsmuth, Barris, Springer, Ulrich, and Cope.

The Survey continued to receive appropriations for active work until 1872, when the old Illinois constitution was abolished and the continuing appropriation for Survey work ceased. At that time several volumes of reports had appeared and others were in course of preparation. For the purpose of completing the reports in hand small appropriations were made until 1875, when all provision for the Survey terminated. At that time six volumes of reports had been issued and two other volumes were partly completed.

In 1877 the State Museum of Natural History was created and placed in control of the geologic collections. The former State geologist, A. H. Worthen, was appointed the first curator of the museum, but he was not provided with funds for field work or for publications. It was not until 1881 that the curator was directed to issue Volume VII of the reports of the former Geological Survey, and the publication of the last volume was not authorized until 1885.

The reports of the first Geological Survey are of a high scientific character and are monuments to the ability of Dr. Worthen and his associates. In addition to reports on 102 counties of the State, the following subjects were treated with greater or less thoroughness: Physical features of Illinois; general geologic principles; surface and stratigraphic geology of the State; paleontology of Illinois rock formations; the "Coal Measures," "sub-Carboniferous" limestone, and the Devonian and Silurian systems; geology of the lead region; coal fields of Illinois; and the origin and formation of the prairies.

So far as can be learned the eight royal octavo volumes were published in editions of 3,000 each and were distributed gratuitously under the direction of the governor. They averaged about 550 pages each. About 285 full-page lithographic plates, besides numerous woodcuts, were published. Altogether about $110,000 was appropriated for the maintenance of the first Survey, including illustration of reports. Apparently the cost of printing and binding came from another fund.

The broad scope of the work of the first Survey has been indicated. Its notable accomplishments were recognized by scientists of the whole world. The pioneer work which it performed in American paleontology is of the highest order and constitutes one of the stand-

ards on which paleontologists of the present day work. The reasons which led to the discontinuance of the Survey are not difficult to find. During the early years Illinois was almost exclusively an agricultural State. Rock formations were largely hidden from view by thick deposits of drift and consequently did not seem to the layman of sufficient importance to warrant expensive study. Coal for fuel, brick and stone for building, and other minerals were not in general use during the days when timber was plentiful. It may well be imagined, therefore, that the expenditure of large sums on investigations of that nature and on the description and illustration of fossils was unappreciated by the early citizens. When, therefore, in 1875 the county reports for the entire State were completed, further work of the Survey was checked by the failure of appropriations.

After the discontinuance of the first Geological Survey there was a period of 30 years of inactivity in geologic investigations in Illinois, the work of that nature performed by the State Museum not being sufficient to justify special mention.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the State Geological Survey; it was organized under act of July 1, 1905.

The first director was Dr. H. Foster Bain, who served until his resignation in 1909.

SUMMARY OF LAWS.

The Survey, which is established at the University of Illinois, operates under the direction of the State geological commission. This commission is composed of the governor, who is the chairman; the president of the University of Illinois; and one other competent person appointed by the governor for a term of four years and until his successor is appointed and qualified. The commissioners serve without compensation, but are reimbursed for actual expenses incurred in the performance of official duties. They have general charge of the Survey, and appoint the director, who, with the approval of the commission, appoints necessary assistants and employees. The salary of the director and of the assistants and employees is determined by the commission.

The objects of the Survey are as follows:

(1) A study of the geologic formations of the State with special reference to its products—coals, ores, clays, building stones, cements, materials for use in the construction of roads, gas, mineral and artesian water, and other mineral resources.

(2) The preparation of geologic and other necessary maps to illustrate the resources of the State.

(3) The preparation of reports, with necessary illustrations and maps which shall include both a general and detailed description of the geologic and mineral resources of the State.

(4) The consideration of such other scientific and economic questions as in the judgment of the commissioners shall be deemed of value to the people.

The director presents to the governor an annual report showing progress and condition of the bureau and such other information as the commission requires. The reports of the Survey are printed and distributed gratuitously as well as sold. All money received from sale of reports is paid into the State treasury.

The printing of reports and of stationery forms a part of the State printing contract, and is under the direction of the board of commissioners of State contracts. The amount thus expended in any one year is limited to $5,000. More recently an appropriation of $2,500 per annum has been made to the State geological commission for preparing and engraving illustrations and maps and for printing and binding reports.

Collections of materials which have served the purpose of the Survey may be distributed to the educational institutions of the State, or be placed in the State Museum of Natural History at Springfield or in the museums at the University of Illinois, as indicated by the commissioners.

The sum of $25,000 per annum is appropriated biennially to provide for the work of the Survey. Vouchers, when approved by the governor, are presented to the auditor of public accounts. For the present biennium the additional sum of $7,500 has been appropriated for the survey of overflowed lands in Illinois.

The commission is authorized to cooperate with the United States Geological Survey in the preparation of a topographic map of the State, and to expend in the prosecution of that work a sum equal to that expended by the Federal Survey, but this amount shall not exceed $10,000 in any one year.

It is lawful for persons employed in the work of the Survey to enter and cross all lands within the State, provided in so doing no damage is done to private property.

ORGANIZATION.

The form of organization of the Survey is outlined in the preceding summary of laws. At present the personnel is as follows:

The governing board is the State geological commission, whose chairman is Gov. Charles S. Deneen; the vice chairman is Prof.

T. C. Chamberlin, of the University of Chicago; and the secretary is President E. J. James, of the University of Illinois.

The executive officer is known as director. The present incumbent, appointed acting director April 1, 1909, and director January 12, 1911, is Frank W. DeWolf. The director is appointed by the commission and holds office at the pleasure of that body. He is required to devote his time exclusively to the official duties of the Survey.

Subordinates include clerical, geologic, chemical, technologic, topographic, engineering, and hydrographic assistants. They may be appointed for any term and at any designated rate of compensation. Appointments may be made by the commission or by the director, subject to approval by the commission. The clerical force includes a chief clerk and a stenographic assistant. In addition, students are from time to time employed for routine work. Salaries of male clerks have ranged from $60 to $125 a month and of female clerks from $30 to $50 a month.

In the organization of the scientific work there are three consulting geologists, two consulting chemists, and one consulting ceramist. The other scientific employees rank as geologists, assistant geologists, and field assistants. The range of pay, in addition to allowance for actual expenses, is as follows: Consulting geologists, $8 per diem; consulting chemists and ceramist, a per diem amount corresponding to the salary of university professors; geologists, $150 to $200 a month; assistant geologists, $100 to $135 a month; field assistants, up to $100 a month.

The three consulting geologists represent the geologic departments of the three largest universities of the State, and are men of extended experience on official surveys. Each of these advisers shares responsibility for the direction of a particular investigation. At present one is adviser in clay investigations, another in studies of lead and zinc, and the third in the preparation of educational bulletins. The service of the consulting geologists is discontinuous, both in the field and in office.

Other geologists of the organization are selected for work in which they are thoroughly experienced and responsible. At present they include three professors, who devote from two to four months of each year to field work and prepare their reports during the succeeding university year as time can be separated from their college duties. Two of these geologists give special attention to paleontologic stratigraphy, and the third to the study of well records and detailed areal and economic investigations.

The assistant geologists include men with several years' experience, who are thoroughly competent to pursue individual work. As a rule two such assistants are employed for full time and from two to four others devote the summer months only to the work of the Survey.

Field assistants may have had little or no practical experience but are required to have had a thorough collegiate instruction in geology. They are usually postgraduate students or instructors in the State universities. Occasionally inexperienced men work without salary but are reimbursed for expenses. From three to six field assistants are employed each year.

APPROPRIATIONS.

Appropriations are made biennially, and for the most part in two annual installments. None are contingent on cooperation.

The fiscal year of the State begins October 1. Appropriations become available July 1, and unexpended balances lapse before October of the following year. Under construction of the auditor, June bills can be paid from the appropriations which become available July 1.

The sum of $25,000 per annum is appropriated biennially, to provide for official expenses incurred by the commissioners and for the payment of salaries (or other compensations) and expenses of the director and other employees. The method of disbursement is by means of vouchers approved by the governor and presented to the auditor of public accounts. In addition to the above regular appropriation there has been appropriated for the present biennium the sum of $7,500 for the survey of overflowed lands in Illinois and $2,500 per annum for preparing and engraving illustrations and maps and printing and binding reports of the Survey.

The average annual expenditures may be classified under the following heads; the percentages are for the current year, but are fairly representative.

	Per cent.
Administrative, and routine clerical work, including postage on bulletins	22
Topographic work	32
Economic, stratigraphic, and areal geology	21.5
Statistics	.9
Chemical work	1.9
Underground water resources	1.6
Drainage surveys	12
Tests of clay	.9
Library	.9
Drafting and engraving	3.8
Educational bulletins	2.5
	100.0

PUBLICATIONS.

The publications of the present State Geological Survey comprise bulletins 1 to 16, inclusive, and circulars 1 to 5, inclusive. The bulletins include the annual administrative reports, a geologic map

of the State, economic reports, special physiographic studies, and reports on the mineral content of the waters of the State and on the water resources of certain districts. The circulars are of a statistical nature and relate to the annual mineral production of the State.

The size of the editions of Survey publications varies from 3,000 to 4,000 copies, according to the character of the report and its probable demand.

A portion of each edition is set aside for gratuitous distribution. To meet the wants of libraries and persons not reached in this first distribution, 500 copies of each edition are reserved for sale at cost, including postage. All money received from the sale of reports is paid into the State treasury. The amount is small, varying from $70 to $100 per annum.

The average annual cost of printing reports and accompanying maps for the last five years is about $5,000. Of this, $1,200 has come from Survey funds, and the remainder from the State printing fund. The cost of cuts for illustrations and of the actual printing of colored maps is paid from Survey funds.

The printing of reports and of stationery forms a part of the State printing contract and is under the direction of the board of commissioners of State contracts. The amount is limited to $5,000 annually. The general size of the volume, character of paper, size of type, and number of lines to the page are prescribed by law, and are under the supervision of the board of commissioners of State contracts. Recently, however, an appropriation of $2,500 per annum has been made to the State geological commission for preparing and engraving illustrations and maps and printing and binding reports, but this is not sufficient to cover the entire cost of the work. Cuts for half-tone and zinc illustrations are furnished by the Survey; they are printed by the State printer. Contracts for lithographed or colored maps are made by the Survey directly with commercial firms, the cost being paid out of Survey funds.

The State geological commission has full control over the distribution of its reports. The mailing list, which includes approximately 5,000 names, is recorded on vertical cards, arranged alphabetically, the subject of special interest to each person being indicated. Thus the cards of those interested in coal can readily be distinguished from those interested in oil or clay. The list is further divided into two main classes, the larger of which includes the names of persons to whom an invitation is sent to remit postage if they desire a particular report. The smaller list includes State officers and legislators, professional exchanges, and the more influential men in the mineral industries, as well as important libraries throughout the country. These receive the reports, post free, as they are issued. As a whole the mailing list includes members

of scientific, engineering, and industrial societies and clubs, operators in the mineral industries, teachers of science, and other persons who from time to time send requests for information.

In order to assist in keeping the mailing list alive notices of new publications are sent out, by "first class" mail, and are therefore forwarded to the addressee if he has changed his residence or returned to the Survey office if undelivered. From time to time, about once in two years, the mailing list is revised by removing from it the names of those who have not returned postage for any of the bulletins issued during that period.

A list of newspapers is kept and press announcements are distributed from time to time.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

The Survey is at present engaged in three main lines of work, as follows:

(1) Surveys and reports of an areal and economic character. These apply either to the whole State for a particular mineral or to a particular area for all minerals.

(2) Systematic reports on the geologic formations. These will probably be published in large volumes, comparable to those of the first Geological Survey of the State. Those on which the Survey is now engaged relate to the Mississippian series of the Carboniferous system and the Devonian system.

(3) Educational bulletins. Reports are rapidly being prepared on areas which include important educational centers. They deal chiefly with physiographic and general geology, and some of them include historical contributions. They are amply illustrated and are designed to popularize geology and the work of the Survey with teachers, students, and citizens generally.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—Cooperation with the Federal Survey includes topographic and geologic surveys and the collection of statistics.

Formal cooperation for topographic surveys is in effect, the annual expenditure by each Survey being $10,000. Less formal cooperation applies to the preparation of drainage maps of overflowed lands. Formerly the drainage maps were prepared entirely at the expense of the State, but for the present biennial period the Federal Survey contributes $2,500 and the State $7,500. The maps are on a scale of 1:24,000 and have a contour interval of 5 feet. Approximately

500 square miles had been mapped before the beginning of the present fiscal year.

Cooperation is also maintained with the Federal Survey for detailed areal, stratigraphic, and economic geologic surveys. This work has been in progress for about four and a half years, and previous to the last field season 11 quadrangles had been mapped. The survey is accomplished by separate State and Federal parties, who work independently, each Survey employing its own methods. All work, however, is subject to inspection by both Surveys, and the data collected are available to both Surveys. Folios will be published by the Federal Survey and bulletins and miscellaneous reports by both Surveys. Heretofore each Survey has contributed $2,000 per annum, but for the present fiscal year each Survey is contributing $2,500.

Besides quadrangle mapping, the two surveys one season joined in a regional study of the Illinois coal fields. For parts of several seasons the Federal Survey detailed David White to conduct reconnoissance correlation studies in the State. Cooperation in a small way is also maintained for the collection and study of deep-well records. In this work a State employee acts as special agent for the Federal Survey, each bureau contributing $300 annually to the expense.

The collection of statistics of the production of Illinois minerals is carried on in cooperation with the statistical division of the United States Geological Survey.

United States Bureau of Mines.—Informal cooperation with the United States Bureau of Mines in the maintenance of a mine rescue station at Urbana, Ill., has succeeded similar cooperation with the United States Geological Survey, of whose technologic branch the Bureau of Mines is the outgrowth. Under this arrangement two Federal employees have been provided, a demonstrating station has been maintained by the University of Illinois, and office accommodations and clerical assistance have been furnished by the State Geological Survey. The latter has also contributed a small part of the salary of the station assistant.

United States Department of Agriculture.—Cooperation with the drainage section of the United States Department of Agriculture was formerly carried on and doubtless will be revived. Under this cooperative arrangement the Federal engineers made reconnoissance maps and drainage plans for the reclamation of overflowed lands along typical rivers, and the State, in cooperation with the United States Geological Survey, surveyed certain other river bottoms, as mentioned in a previous paragraph.

Other State scientific bureaus.—There is considerable cooperation between the State Geological Survey and several departments of the University of Illinois. From time to time members of the laboratory

force of the university are employed directly by the Survey. Again, an allotment is made to the cooperating department of the university which furnishes the help required for a specific investigation. To the present time work of this nature has been devoted chiefly to chemical research on coal and to practical tests of the clays of the State.

At present the State Geological Survey and the Internal Improvement Commission have a cooperative arrangement for drainage investigations in Illinois. The Survey provides large-scale drainage maps, previously described, and the Internal Improvement Commission makes the necessary engineering studies on which to base plans for the reclamation of flooded lands. The commission also bears the expense of maintaining numerous gaging stations along the rivers which are under investigation.

In the past there has been cooperation between the State Geological Survey and the State Water Survey in the collection and analysis of representative ground waters of the State, the results of which were incorporated in a volume on the composition of Illinois waters. In this study the engineering experiment station of the University of Illinois and the United States Geological Survey also participated.

There has also been cooperation with the State highway engineer in the study of road materials and the selection of sites for State quarries. Doubtless work of this nature will be resumed from time to time, as appropriations permit. Cooperation with the new department of mining at the University of Illinois, in a study of coal mining in Illinois, is in contemplation.

INDIANA.

HISTORICAL SKETCH.[a]

The Department of Geology and Natural Resources of Indiana was evolved from perhaps three antecedent State bureaus. The first of these was the State Board of Agriculture, which had to do almost entirely with the science and art of agriculture as carried on in the State. The work at this time, more than 60 years ago, was done by reports on agricultural conditions from individual counties and by addresses by prominent educators or those well versed in the science of agriculture. Later the Board of Agriculture was enlarged by the addition of a Bureau of Statistics. Hence, in addition to agricultural research, statistics on agriculture, manufacturing, schools, and business were compiled and included in the annual report of the Bureau of Agriculture and Statistics. Still later, partial geologic surveys had been made that attracted the attention of the officials of the State, and the Department of Geological Survey was added to the Bureau of Agriculture and Statistics. As population increased and work of these various branches increased, the necessity of a separate department of geology and natural resources became imperative, and in accordance with this demand the general assembly of 1881 enacted a law establishing the Department of Geology and Natural History for the State of

[a] Letter from Edward Barrett, State geologist.

Indiana. The purpose of this bureau was to continue the geologic and scientific survey of the State, to discover and develop the State's natural resources, and to disseminate such information among the people. Under the law of 1881 the governor appointed a competent and suitable person to be State geologist, with the power to call to his assistance such help as he deemed necessary, but he was limited in the expenditure of money for this help to the amount authorized by the general assembly. The geologist's term of office was four years, and he might be removed by the governor for cause. His compensation was $1,800 per year. The geological department was established in the State house in Indianapolis, and the care of the State museum was a part of the geologist's duty. He was required to make an annual report to the governor concerning his labors and discoveries, and all scientific information was to be compiled in the form of an annual report, of which 5,000 copies were to be issued. An appropriation of $5,000 annually was made, from which the salary of the geologist and his assistants and all expenses of the Department were to be paid, and any unexpended balance should be returned to the State treasury. The work of the Board of Agriculture was carried on as a separate branch of the State administration, and a Bureau of Statistics was established as a separate branch also, with enlarged powers and duties.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is known as the Department of Geology and Natural Resources; it was organized in 1881. A later law, enacted in 1907, changed the State geologist's salary to $3,000.

ORGANIZATION.

The governing board and the executive officer are the State geologist, who is elected by the people for a term of four years, at a salary of $3,000 a year and traveling expenses. His entire time is devoted to the duties of the Department of Geology and Natural Resources. The present incumbent is Edward Barrett, who was elected November 8, 1910, and entered upon his term of office January 1, 1911.

The subordinates include one stenographer, one custodian, two chemists, two hydrographic engineers, and six field assistants on the soil survey. The stenographer and custodian are employed by the year; the term of service of field assistants is indefinite. All are appointed by the State geologist. The salaries range from $60 to $100 a month.

In hydrographic and soil surveys college professors and students are employed.

APPROPRIATIONS.

Appropriations are made by the State legislature biennially. Unexpended balances are returned to the State treasury immediately after the close of the fiscal year, September 30. The annual appro-

priation for office expenses and pay of field assistants is $3,800, disbursed as follows:

	Per cent.
Administrative work	30
Field assistants	60
Office supplies	10

PUBLICATIONS.

The publications consist of a series of annual reports which vary in size from 500 to 1,000 pages. The size of the editions is 5,000 copies. The reports are sent out by mail and express, free of cost to the recipient.

The annual cost of printing reports is from $3,000 to $4,000, which comes from the general fund. The State geologist has full control of the printing of maps, reports, and illustrations and of the distribution of reports. Reports are sent to colleges, libraries, schools, and educators, to county auditors for distribution, and incidentally to persons who make application for copies.

PRESENT LINES OF WORK.

The Department is at present engaged in a hydrographic survey of rivers and a soil survey of the State by counties. Cooperation with other organizations is not maintained.

IOWA.

PREVIOUS SURVEYS.

The first geologic work in Iowa was that of Dr. David Dale Owen, who in the autumn of 1839 surveyed parts of Iowa, Wisconsin, and Illinois, under the direction of the United States Land Office, in accordance with congressional instructions. It was intended primarily to determine the value of the mineral (lead-bearing) lands centering about Dubuque, Platteville, and Galena. However, the actual accomplishment was considerably broader than this, as Owen attacked problems relating to the stratigraphy and paleontology of the district as well as those of a purely economic nature. For skillful organization and rapidity and thoroughness of execution this survey has probably never been excelled, when all the limitations are considered.

In 1847 the United States Treasury Department sent Dr. Owen into the Mississippi Valley, to make a reconnoissance of the Chippewa land district, lying chiefly in Wisconsin but including also that part of northeastern Iowa lying north of the area already surveyed by Owen, as well as a portion of southeastern Minnesota. Dr. Owen's

time was again limited, only the summer and autumn of 1847 being devoted to field work. Like his previous survey, this survey also shows his marvelous ability for accomplishing a great amount of work in a brief space of time.

He devoted considerable attention to the lead deposits and their associated rocks and also made extended studies of the geologic formations of the territory.

The results of these two surveys were published as congressional documents, in single octavo volumes, each accompanied by a map and by colored sections and plates.

On the completion of these preliminary surveys Owen was instructed to make a survey of the Northwest Territory. This time his work covered the States of Wisconsin, Iowa, and parts of Minnesota and included some studies of vertebrate fossils from the badlands of Nebraska. The manuscript of his final report was submitted in 1851 and published in 1852. It consisted of a large quarto volume, with 15 plates of fossils, 19 geologic sections, and a geologic map. As with his previous investigations his commission terminated with the submission of his report.

The illustrations for all of Owen's reports were largely reproduced from his own drawings, and for accuracy of detail and beauty of execution these have rarely been equaled.

The next geologic work in Iowa was initiated by the State itself, when in 1855 it authorized the organization of a State Geological Survey. James Hall was appointed State geologist. He carried on the work from 1855 to 1858 and published a report in one volume bound in two parts. The first part dealt with the physiography and geology of the eastern part of the State, and the second part treated the paleontology of the same district. Previous to the completion of this report Hall published, at the end of the year 1856, a small report of progress. In this survey Hall was assisted by J. D. Whitney, A. H. Worthen, B. F. Meek, and R. P. Whitfield, men who later became widely known for their contributions to geologic knowledge. The organization was discontinued by legislative enactment in 1859.

In 1866 the legislature passed "An act providing for the completion of the geological survey of the State of Iowa," and appointed Charles A. White State geologist for a term of two years. Dr. White spent the years of 1866 and 1867 mainly in an examination of the southern and southwestern parts of Iowa and in a study of the coal fields of the State. At the close of 1867 the first and second annual reports were submitted, together with a number of popular letters which had been written for the newspapers. The next general assembly, in 1868, required the survey to be completed by January 1, 1870. Under this act a survey of the northwestern part of the State was made, and a report was prepared and presented to the general as-

sembly in 1870. This report dealt with the physical geography, surface geology, and general geology of the region, the method of treatment being a detailed discussion by counties; also with the mineralogy, lithology, and chemistry of the economic products of the State. The report was ordered printed in two royal octavo volumes. As no provision was made for the continuance of the work the survey ceased to exist. Dr. White's assistants were T. S. Parvin, O. H. St. John, and Rush Emery.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the Iowa Geological Survey; it was organized in 1892.

SUMMARY OF LAWS.

The Survey is under the direction of the geological board, consisting of the governor, the State auditor, and the presidents of the State University, the Agricultural College, and the Iowa Academy of Sciences. The board appoints the State geologist and his assistants. The State geologist is directed to make a complete survey of the natural resources of the State in all their economic and scientific aspects. He is to prepare detailed maps and reports of counties and districts as fast as their survey is completed, and the results of any special investigations may be published whenever the information obtained warrants it. He is to cooperate with the United States Geological Survey and with adjoining State surveys in the making of topographic maps and in the study of the geologic problems of the State. He is to present to the board before the 1st of January of each year a report of the work of the preceding year, together with such minor reports and papers as may be considered desirable for publication.

The annual reports, together with such other special reports as may be ordered printed, are published by the State, but the distribution of the entire edition is left to the State geologist.

The expenses of the board and of the members of the Survey staff are paid from the Survey appropriation, which is $8,000 annually. Postage, stationery, and office expenses are paid by the State out of funds set apart for that purpose, as are also the cost of printing, binding, and distributing the reports of the Survey.

ORGANIZATION.

The Survey is under the control of the geological board. The five members of this board serve ex officio, and their terms of office are dependent on the length of term of the positions by virtue of which

they become members of the board. They receive no compensation for their services but are reimbursed for actual expenses incurred in attending the meetings of the board.

The title of the executive officer is State geologist. He is appointed by the geological board and holds office at its pleasure. The present incumbent is Samuel Calvin. He was appointed at the time of the organization of the Survey, in 1892, and served until July 1, 1904. He was reappointed in April, 1906, and has held the position until the present time. Dr. Calvin is at the head of the department of geology at the State University of Iowa. He devotes one-third of his time to Survey work. The compensation of the State geologist is fixed by the geological board and is at present $900 per annum.

The Survey employs two clerical assistants, both chosen by the State geologist. One is stationed in the office at Des Moines and is secretary to the geological board; the other is a temporary assistant and is chosen from the student body of the State University. Both serve at the pleasure of the State geologist. The salary of the secretary to the board is $1,100 per annum. This is paid by the State, from the clerk fund, and does not come out of the Survey's appropriation. The temporary clerk receives $10 a month.

The geologic assistants include an assistant State geologist and from 8 to 10 special assistants. The latter are college instructors or advanced college students. The assistants are appointed by the geological board, on the recommendation of the State geologist, and serve at the discretion of the board. For surveying a county and preparing a report an assistant receives $150; for work of other classes a monthly salary is paid, ranging from $60 to $100. The assistant State geologist is located at Des Moines. His salary is fixed by the geological board at $1,500 per annum.

APPROPRIATIONS.

The appropriations of the Survey are continuing. They hold over from year to year without specific legislative action. They are not contingent on cooperation with the United States Geological Survey or other State surveys, although the amount of the appropriation was increased in order to permit such cooperation.

Unexpended balances revert to the State treasury at the close of the fiscal year.

The annual appropriation is $8,000. The objects, so far as specified by law, are a survey of the natural resources of the State, in all their economic and scientific aspects, also cooperation with the Federal and other State surveys in the making of topographic maps and the study of geologic problems common to the States. The amount which may be spent in cooperative work is not fixed by law, but by the rule of the geological board the annual expenditures for

topographic work in cooperation with the United States Geological Survey has been fixed at $1,750 per annum.

During the fiscal year 1909 to 1910 the Survey expenses were divided about as follows:

	Per cent.
Administrative work	21.45
Topographic work	21.85
Geologic work	42.60
Statistical work	1.25
Chemical work	2.70
Underground waters	5.00
Stream flow, etc	4.20
Testing road material, etc	1.00

PUBLICATIONS.

The publications of the Survey comprise annual reports, supplementary reports, bulletins, and maps. Of the annual reports 17 have been issued and the eighteenth is in press. The edition is limited by statute to 3,000 copies, 2,200 of which are bound in cloth, 300 in paper, and the remaining 500 are broken into the separate papers. Three supplementary reports have been issued, also in editions of 3,000 copies. Three bulletins have been published, but there is no limit set by law to the size of the edition. Of Bulletin 1, 3,000 copies were printed; of Bulletin 2, 5,000 copies; and of Bulletin 3, 1,000 copies. In addition to the maps which are bound in the reports, one large wall map of Iowa, scale 8 miles to the inch, has been published, the edition being 5,000 copies.

The publications are usually distributed free to citizens of the State. When copies are sold the actual cost of publication is charged. Transportation charges are usually asked of persons outside the State. The income from these sources, however, is not large. In 1909 it amounted to $29; in 1910 to about $65. All funds received are turned into the State treasury.

The cost of publication of the last five annual reports, including printing, binding, maps, and engravings, has varied from $1,492 to $4,062, the average being $2,927. The cost is paid by the State, out of funds set aside for that purpose.

The reports of the Survey, as well as of all other departments of the State, are printed by the State printer and bound by the State binder. The style of the report was determined by the Survey at the time of its organization and has been kept uniform ever since. There is no restriction as to the number of pages in the reports. Paper is chosen by the executive council of the State. The Survey is given a better quality of paper than most of the State departments, in order that the halftone illustrations may be printed in the body of the text.

The illustrations are selected by the Survey, but are subject to the approval of the executive council. The zinc plates and halftones used are made by a firm which has a contract with the State for all such work. All illustrations, except lithographed work, whether in the body of the text or separate, are printed by the State printer. There is no restriction upon the contents of the reports, except that they must be approved by the governor.

Lithographed maps are made under contract. Specifications are drawn by the Survey and the contract is awarded by the executive council.

The law gives the State geologist full control over the distribution of the reports. There is a rule of the geological board, however, that when the number of copies of a report has been reduced to 300 a price shall be charged for all future copies sent out. The executive council also holds in reserve 100 copies of each report and this number can not be drawn upon except by permission of the council.

The mailing list comprises geologists and persons interested in geology, both in Iowa and in other States, as well as in many foreign countries; most of the State geological surveys and many other leading scientific organizations of the United States and foreign countries; the public schools and public libraries of Iowa; numerous public libraries outside the State; and the schools and other institutions controlled directly by the State, as well as those under private or denominational management. In addition copies are sent to the various officers and departments of the State government. The list is kept alive by the requests of interested persons and organizations to be included, by supervision of the State geologist, and by requests from this Survey for exchanges.

PRESENT LINES OF WORK.

Independent investigations.—The Survey is carrying on several lines of work, which may be specified as follows: (*a*) Study of the areal geology of the State by counties. The State geologist is also preparing a report covering the areal geology of the State as a whole, and the assistant State geologist is preparing a similar report on the physiography of the State. (*b*) Investigation of the economic geology of the State by subjects. At present work is being prosecuted on road materials, concrete materials, and water powers of the State. (*c*) Investigation of underground water resources and collection of well data. (*d*) Study of special problems, including, at present, the loess deposits of Iowa and neighboring States and the distribution of the drift sheets of the State.

Cooperation with the United States Geological Survey.—The State Survey is cooperating with the Federal Survey in topographic map-

ping and in the collection of mineral statistics. In the topographic mapping the State and Federal surveys allot equal sums for the work. The Federal Survey pays the salaries of permanent field employees, and the State Survey pays all field expenses and salaries of temporary employees. Thus far three quadrangles have been mapped and work on a fourth will be begun during the present season. All mapping is on the scale of 1:62,500. In the collection of mineral statistics, blanks are sent to producers by the Federal Survey and the State Survey looks after delinquents. Duplicate copies of the individual reports are sent to the State Survey, and the data are compiled and the results published as a part of its annual report.

KANSAS.

PREVIOUS SURVEYS.

FIRST GEOLOGICAL SURVEY.

The first State Geological Survey of Kansas was authorized by an act of the State legislature in 1864. Section 1 of the act provided that the governor, with the consent of the senate, should appoint a State geologist, whose term of office should begin on March 1, 1864, and end March 1, 1865. Section 2 provided that the State geologist should equip a proper laboratory, should procure necessary assistants, and should proceed to classify the rocks and soils of each county in the State; that he should visit and analyze the salt springs already discovered, and use due diligence in discovering others; and that he should investigate the coal formations and other mineral deposits of the State by the various appliances known to the science of geology and mineralogy. It further provided that he should immediately report any discoveries of valuable deposits or other materials of importance to the State, and that he should prepare and deposit with the State librarian a cabinet of correctly labeled geologic specimens illustrating the geology of the State. Section 3 provided that during the month of November, 1864, the State geologist should deliver to the governor his annual report, which should contain a complete exposition of the work accomplished. Section 4 provided that the State auditor should draw State warrants for the expenses of the Survey in such sums as in his opinion were necessary, not, however, to exceed $3,500 during the year. Section 5 provided that the State geologist should execute a bond to the State in the sum of $5,000, guaranteeing the faithful and proper performance of the duties of the office, and that he should take the ordinary oath of office. Section 6 provided that the governor should have power to remove the State geologist for incapacity or neglect of duty and to

fill any and all vacancies that might occur by death or otherwise. Section 7 provided that this act should be in force from and after its proper publication in the State paper. The act was approved by Governor Thomas Carney on February 10, 1864.

Under the foregoing act the governor appointed Prof. B. F. Mudge State geologist, Maj. Frederick Hawn assistant geologist, Prof. G. C. Swallow paleontologist, Tiffin Sink chemist and meteorologist, and C. A. Logan botanist.

The first annual report of the Survey appeared in 1866 and consisted of a pamphlet of 56 pages.

SECOND GEOLOGICAL SURVEY.

In 1865 the legislature passed a new act regarding the State Survey. Section 1 provided that the governor, with the consent of the senate, should appoint the State geologist, whose term of service should begin on the 1st day of March, 1865. No time limit was added to this appointment. Section 2 provided that $7,500 should be appropriated for the prosecution of the work during that year. Section 3 provided for the manner of payment by the State auditor, and section 4 provided that the act should take effect and be in force from the date of proper publication. This act was approved by Governor S. J. Crawford on February 11, 1865. Under it the governor appointed Prof. G. C. Swallow State geologist, and all the assistants who served during the preceding year were continued. Prof. Mudge, however, was not reappointed to any position on the Survey.

The State geologist of this Survey submitted a report consisting of 162 pages, which was issued in pamphlet form in 1866.

The succeeding legislature failed to make any appropriation for the bureau, so that the second Geological Survey continued during one year only.

At different times between 1866 and 1893 various citizens tried to revive the State Geological Survey, but each time without success. During that interval a bill was introduced for this purpose at almost every session of the legislature, showing that a very considerable interest in the matter was kept alive throughout the State

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present Survey is known as the State Geological Survey of Kansas; it was organized in 1895, under the law of 1889, which was amended in 1907.

SUMMARY OF LAWS.

The State legislature which met in 1889 in a measure remodeled the laws governing the State University, and specified that one of the functions of the university was to organize and conduct a State Geological Survey. Preliminary work on the Survey was begun in 1893 by Profs. Erasmus Haworth and S. W. Williston and their advanced students. By 1895 sufficient progress had been made to warrant the regents in formally organizing a State Geological Survey, which they did in accordance with the law of 1889 already mentioned.

The work of the Survey was for a number of years continued under the name, University Geological Survey of Kansas. At every session of the legislature a direct appropriation was made for it by a bill independent of the general university appropriation bill.

To meet the objection of certain members of the legislature that the Survey was not established on a substantial legislative act, the legislature of 1907 passed a special act (chapter 395) providing for the permanent continuance of the Survey, for the officers of the same, and for the printing of its reports. Section 2 of this bill provides that the chancellor of the University of Kansas shall be ex officio director of the Survey and that the immediate work of the Survey shall be directed by the State geologist, who shall be appointed by the chancellor of the university and shall be a member of the department of geology of that institution. It also provides that he shall prepare and submit to the chancellor for publication all reports of the Survey. Section 3 provides that the State geologist shall prepare for publication and submit to the chancellor from time to time such reports on the geology of the State as he and the chancellor may consider advisable. Section 4 provides that the State printing board shall have printed 5,000 copies of each of the reports provided for in section 3 and makes further provision for the distribution of the reports. This act was approved March 9, 1907, and was officially published and became a law March 14, 1907.

ORGANIZATION.

The form of organization is outlined under the foregoing "Summary of laws." The compensation of officers and other employees is not mentioned in the law, all matters of that nature being left to the board of regents.

The chancellor of the University of Kansas is ex officio director of the Survey. The present chancellor is Frank Strong. Erasmus Haworth, at the head of the geological department of the university, is State geologist. He devotes about half of his time to the work of the Survey and the remainder to his university duties.

The clerical work of the Survey is performed by the regular clerical force of the university, except the stenographic assistance, which is rendered by a special stenographer.

The number of geologic assistants varies from four to twelve. They usually are advanced students of the university; most of them work without other compensation than their field expenses and the credits which are given them toward degrees in the university. The chemical work is done in part by the chemical department of the university and in part by a special chemist employed for special purposes.

The Survey has done no topographic work. During the summers of 1895 and 1896 the entire force of the Survey was employed in investigating ground-water conditions in the western part of the State. Since then it has given little attention to the water resources.

APPROPRIATIONS.

Appropriations for the Survey were made by special acts of the legislature until after the passage of the act of 1907. Since the passage of that act the appropriations have been included in the general university budget. They are biennial in duration, as the State constitution prohibits the legislature from making continuous appropriations. Unexpended balances lapse into the State treasury July 1 of each year.

The annual appropriations for actual expenses in the field and laboratory and for the services of a stenographer have varied from $1,500 to $3,000 annually. All other clerical work, all printing, all office accommodations, power, light, heat, stationery, library facilities, etc., are provided by the university.

The annual appropriation is not divided into several parts. It is the practice of the Survey to undertake a definite piece of work and devote practically all appropriations to it until it is completed.

PUBLICATIONS.

The publications of the Survey comprise nine volumes, averaging about 500 pages each. Five of these are devoted to economic geology. Of the other four, one relates to the general stratigraphy of eastern Kansas, one to the general geology of western Kansas, and two to the Cretaceous and Carboniferous paleontology of the State.

The size of the edition is usually 5,000 copies. The volumes are bound in cloth.

From 1897 to 1903, inclusive, the Survey also issued a series of pamphlets on the mineral resources of Kansas.

The average annual cost of printing probably approximates $2,500 a year.

All printing must be done under the direction of the State printer, who may, if he desires, order any part of it done at other printing offices.

By law 750 copies of each report are delivered to the State legislators, 60 copies are delivered to the State Historical Society, and other copies are used in a world-wide exchange of publications. The citizens of the State are supplied with reports as long as they last, on the payment of postage.

The only mailing list that is kept is the exchange list.

PRESENT LINES OF WORK.

Independent surveys.—The Survey is at present directing its energies to a study of the clays of the State. The investigation preceding this was on coal-mine explosions, the report of which is nearly ready for the printer.

Cooperation with United States Geological Survey.—Cooperation with the Federal Survey is carried on in the collection of statistics of mineral production.

Other cooperative work.—Recently cooperation to a small extent has been had with two outside organizations in a study of Permian paleontology.

MAINE.

PREVIOUS SURVEYS.

By act of the State legislature dated March 28, 1836, a geologic survey of the State of Maine was authorized. Charles T. Jackson was appointed State geologist. The investigation was continued during the following three years. The published results, considering the difficulties of transportation at that time and the nonexistence of accurate maps, are interesting. They include three annual reports, entitled "Geology of the State of Maine," and dated 1837, 1838, and 1839; a report entitled "Report of an exploration and survey of the territory on the Aroostook River;" and a report entitled "Second annual report of the geology of the public lands belonging to the two States of Maine and Massachusetts."

In 1861 and 1862 a detailed survey and report of the natural history and geology of the State was made by C. H. Hitchcock, geologist, and Ezekiel Holmes, naturalist. Reports on the zoology and botany of the State were included, but the most interesting and detailed reports treated of the geologic resources.

In 1867 a hydrographic survey of the State was authorized by the legislature, the work being intrusted to Walter Wells. His report on the water resources of the State and the location of water-power sites is considered an authority even to the present day. A large por-

tion of the report consists of the description, by towns, of developed water powers and undeveloped power possibilities. The fact that there are more than 1,500 lakes in Maine, or 1 lake to each 20 square miles of territory, will give an idea of the magnitude of hydrographic surveys in the State.

PRESENT SURVEYS.

TITLES AND DATES OF ORGANIZATION.

At the present time there are two organizations in the State working along geologic and hydrographic lines. They are known as the Maine State Survey Commission and the Maine State Water Storage Commission. The first organization was authorized by act of the State legislature dated March 16, 1899. Its powers were subsequently amended and enlarged by an act approved March 23, 1905. The creation of the State Water Storage Commission was authorized by act of the legislature dated April 2, 1909.

SUMMARY OF LAWS.

The following are the laws creating the two commissions described above:

An act to authorize a topographic survey of the State in cooperation with the United States Geological Survey.

[Laws of Maine, 1899, chap. 99.]

SECTION 1. That the governor be, and is hereby, authorized to appoint a commission, to consist of three citizens of this State, qualified by education and experience for such service, to confer with the Director or the representative of the United States Geological Survey and to accept its cooperation with this State in the preparation and completion of a contour topographic survey and map of this State, which is hereby authorized to be made. Said commission shall serve without pay, but all its necessary expenses shall be approved by the governor and paid out of the State treasury. Said commission shall have power to arrange with the Director or representative of the United States Geological Survey concerning this survey and map, its scale, method of execution, form, and all details of the work, in behalf of this State, and may accept or reject the work executed by the United States Geological Survey. And it is hereby provided that said map shall accurately show the outlines of all townships, counties, and extensive wooded areas in this State, as existing on the ground at the time of the execution of these surveys; the location of all roads, railroads, streams, canals, lakes, and rivers, and the location and height of all dams; and shall show by contour lines the elevation and depression of the surface of the country.

SEC. 2. Said commission may expend for the prosecution of this survey a sum equal to that to be expended upon the same work by the United States Geological Survey, not to exceed at the rate of $2,500 annually, for the years 1899 and 1900, and the governor is hereby authorized to draw his orders on the State treasury for such portions thereof as may be required from time to time,

from moneys not otherwise appropriated, upon receipt of vouchers signed by not less than two members of the commission.

SEC. 3. For the purpose of making the surveys hereinbefore provided for, it shall be lawful for the persons employed in making the same to enter upon all lands within the boundaries of this State; but this act shall not be construed as authorizing any unnecessary interference with private rights.

Approved March 16, 1899.

An act to amend an act authorizing a topographic survey of the State.

[Laws of Maine, 1905, chap. 144.]

SECTION 1. The commission directed with the execution of this work shall hereafter be known as the State Survey Commission, the chairman of which shall be the State geologist, and shall include in its work the topographic, hydrographic, and geological surveys of the State as provided by acts and resolves of preceding legislatures.

SEC. 2. Said commission is authorized to distribute without charge, for the use of public libraries, and for other educational purposes, such maps and reports relating to the work of the commission as may become available.

SEC. 3. Said commission shall make report, biennially, to the governor and council, showing work accomplished, together with a detailed account of expenditures, and shall be authorized to print and distribute, from time to time, such report and bulletins as may in the judgment of said commissioners be immediately useful and profitable to the people of the State, the expense thereof to be chargeable to, and paid out of, the appropriation herein made.

SEC. 4. Said commission shall be reimbursed for all necessary expenses as approved by the governor and council, and, in addition, the chairman shall be paid an annual salary of $600 and the remaining members of the commission each $300 annually.

SEC. 5. It is further provided that there shall be and hereby is appropriated for the work of said commission, including all expenses, the sum of $10,000 for the year 1905 and a like sum for the year 1906.

SEC. 6. All acts and parts of acts inconsistent herewith are hereby repealed.

Approved March 23, 1905.

An act to create a State Water Storage Commission.

[Laws of Maine, 1909, chap. 212.]

SECTION 1. The governor, with the advice and consent of the council, is authorized to appoint three citizens of the State, who, together with the governor and the State land agent, shall constitute a commission to be known as the State Water Storage Commission, of which the governor shall be chairman. As members of said commission they shall receive no salaries but shall be paid their actual and necessary expenses incurred in the performance of their duties and may employ a competent engineer. The office of the commission shall be at the State house in the city of Augusta. The commission may appoint a secretary who shall be paid a salary not to exceed $600 per annum, who shall work in conjunction with the land agent.

SEC. 2. The commission shall proceed at once to collect information relating to the water powers of the State, the flow of rivers and their drainage area, the location, nature and size of the lakes and ponds in the State and their respective value and capacity as storage reservoirs, with a view to conserving and increasing the capacity of the water powers of the State.

SEC. 3. The commission shall, so far as possible, work in conjunction with the State Survey Commission, and with such State Survey Commission join with the United States Geological Survey in making a topographic survey of the State in so far as it relates to the collection of data bearing on the water powers and water-storage reservoirs of the State. The State Survey Commission shall place at the disposal of the State Water Storage Commission all information, and copies of reports, maps, and plans collected by them and bearing on the hydrography of the State.

SEC. 4. Every person, firm, or corporation, before commencing the erection of a dam for the purpose of developing any water power in this State, or the creation or improvement of a water-storage basin or reservoir for the purpose of controlling the waters of any of the lakes or rivers of the State, shall file with said commission for its information and use copies of plans for the construction of any such dam or storage basin or reservoir and a statement giving the location, height, and nature of the proposed dam and appurtenant structures and the estimated power to be developed thereby, and in case a dam is to be constructed solely for the purpose of water storage and not for the development of a water power at its site, plans and statements shall be filed with the commission showing the extent of the land to be flowed, the estimated number of cubic feet of water that may be stored, and the estimated effect upon the flow of the stream or streams to be affected thereby. Every person, firm, or corporation shall, as soon as practical after this act takes effect, file similar plans, reports, and estimates in relation to any dam or storage basin or reservoir then in process of construction by them.

SEC. 5. The commission shall present to the legislature on or before the 15th day of January, in the year of our Lord 1911, a report showing the progress made in its investigations to such an extent before January 1, in the year of our Lord 1911, as will enable it to present in its report a comprehensive and practical plan for the improvement and creation of such water-storage basins and reservoirs as will tend to develop and conserve the water powers of the State. The commission shall also report so far as its investigation will permit on the present development of the water powers in the State with reference to the general plan proposed, so that the legislature may have before it a comprehensive summary of the possibilities that lie in the development of the water powers in the State as a natural resource and the necessary steps that should be taken by the State to further conserve and increase them.

SEC. 6. So far as any proposed plan devised by the commission for the improvement and increase of water-storage basins or reservoirs shall include the construction of a dam or dams upon or at the headwaters of any river or watercourse, the commission shall ascertain and report as nearly as may be the water-storage capacity in cubic feet of the reservoir to be created, the recorded rainfall on the watershed above such proposed dam, and the maximum, minimum, and average flow of water per second in cubic feet during each month in the year in said river or watercourse. They shall as nearly as practicable estimate the increased power that would be developed by such proposed dam in the rivers or streams to be affected thereby.

* * * * * * *

SEC. 8. The commission shall ascertain what townships or parts of townships of land can be purchased by the State and the cost thereof, with all the necessary data for a correct understanding of their value as a forest reserve or for conserving the water powers of the State, or for reforestation, and shall further investigate the question of denuded, burnt over, or barren lands in the State, their extent and value, with a view to their purchase by the State for reforestation.

SEC. 9. The sum of $5,000 for the year 1909 and $5,000 for the year 1910, or so much thereof as may be necessary, is hereby appropriated out of any fund in the treasury of the State, not otherwise appropriated, to carry out the provisions of this act.

Approved, April 2, 1909.

ORGANIZATION.

The State Survey Commission is composed of three members, appointed by the governor, with no fixed term of office. The compensation of these commissioners is noted in the abstract of laws given above. The chairman of the commission, who is by law also State geologist, is C. Vey Holman.

The State Water Storage Commission is composed of five members, including the governor, the State land agent, and three citizens of the State appointed by the governor. As members of this commission they receive no salaries but are paid the actual and necessary expenses incurred in the performance of their duties.

By an agreement dated December 1, 1909, between the Director of the United States Geological Survey, the chairman of the State Survey Commission, and the chairman of the State Water Storage Commission, the work of the three surveys in the State is brought under one direction. This agreement provides for a cooperative survey of the natural resources of Maine, including the continuation of topographic mapping; a determination of the amount and availability of water resources, their present development, and the best methods of their future utilization, and the determination of geologic resources.

Under this agreement the executive officer is to be a duly appointed employee of the United States Geological Survey, with the title of district engineer. The present incumbent is Cyrus C. Babb, who was appointed by the Director of the United States Geological Survey December 8, 1909, the appointment being approved by the governor, Hon. Bert M. Fernald. Under the law the district engineer is required to establish his headquarters at the State capitol in Augusta, Me. His salary, which is annual, is determined by his appointment on the United States Geological Survey through the United States Civil Service Commission, and under the terms of the agreement above described it may be paid from any of the allotments of the three organizations which are parties thereto.

Assistants are either appointed by the executive officer or detailed from the United States Geological Survey and are classed as clerical, geologic, engineering, and topographic. One clerk only is employed, the appointment being made by the district engineer, and the compensation being from $40 to $50 a month. The geologic assistants are detailed by the Director of the United States Geological Survey as

required, the compensation being as determined by civil-service appointment. Those engaged in hydrographic surveys include the following: One assistant engineer, detailed from the United States Geological Survey on recommendation of the district engineer, compensation $1,600 to $1,800 per annum; two field assistants, appointed by the district engineer, compensation $60 to $75 a month; two junior topographers, detailed by the Director of the United States Geological Survey, salaries about $90 a month; one field assistant, either the professor of civil engineering in the State University or one of the assistant professors, compensation $75 to $150 a month; and the necessary field laborers. The topographers and assistant topographers engaged in the topographic surveys are detailed from the topographic branch of the United States Geological Survey, and their compensation is from $75 to $200 a month.

APPROPRIATIONS.

The appropriations of the State organizations are made biennially, and in general unexpended balances lapse to the State treasury. Under a recent State law appropriations are not available until 90 days after approval of the act by the governor. The old appropriations, however, are in force until the new ones are available. Although the fiscal year ends December 31, the old appropriations usually do not lapse until about July 1. The appropriation of the State Survey Commission is contingent on cooperation with the United States Geological Survey; the appropriation of the State Water Storage Commission is not so restricted.

The annual appropriation for the Survey Commission is $10,000 and of the Water Storage Commission $5,000. Under the terms of the cooperative agreement of December 1, 1909, the amount available for the current fiscal year, for topographic, geologic, and hydrographic investigations in the State is $23,000.

The expenditures, in percentages, are about as follows:

	Per cent.
Administration	10
Topographic surveying	37
Geology	8
Gaging streams and surveying river profiles and lake storage basins	33
Investigations of water powers, developed and undeveloped	12

PUBLICATIONS.

The reports of the State Survey Commission are pamphlets of 8 to 12 pages each, giving in condensed form the results of the work during each biennial period. Five such biennial reports have been issued.

The State Water Storage Commission has not yet made a report. One of the purposes of its creation was to assemble all available data bearing on the water powers and water resources of the State in the files of the different bureaus of the National Government as well as in the State files, and present them in a comprehensive report for the use of the citizens of the State.

The results of the cooperative work of the State Survey Commission and the United States Geological Survey have been published from time to time in the reports of the National Survey. Up to the present time the State organization has expended its money on field work.

PRESENT LINES OF WORK.

The two State commissions are working in cooperation with the United States Geological Survey, as already described. The special lines of investigation are geologic surveys, topographic surveys, and investigations of water resources. The investigations of water resources, which are designed to conserve and increase the water powers of the State, include the collection of information relating to developed and undeveloped water powers, the flow of rivers and their drainage areas, and the location, nature, and size of the lakes and ponds and their value and capacity as storage reservoirs.

MARYLAND.

PREVIOUS SURVEYS.

The first Geological Survey of Maryland dates from 1833, when, on March 6 and March 16, resolutions were passed by the general assembly of the State providing for the organization of official scientific work. Under the first resolution the governor and council were authorized to appoint a competent engineer to prepare "a plan and drawing for a complete map of Maryland," and also to make such "further examinations and surveys as may be requisite, for the purpose of exhibiting the prominent geographic and topographic features of the country; and also to collect such statistical information as will be useful and is generally exhibited on modern improved maps." Under the second resolution the governor and council were authorized to appoint a geologist "to act in conjunction with said engineer" and to "make the necessary geological researches and report to the governor and council before the next session of the general assembly, upon the expediency and the probable cost of a geological survey of the State." In accordance with these resolutions J. H. Alexander was appointed engineer and J. T. Ducatel geologist. The result of this preliminary survey formed the basis of a joint report to the general assembly, and on February 25, 1834, an act was passed "for

making a new and complete map and geological survey of this State," and Messrs. Alexander and Ducatel were again appointed engineer and geologist, respectively.

Maryland was thus the third State to establish an official Geological Survey, being preceded by only Massachusetts and Tennessee, although some beginnings had already been made by South Carolina and North Carolina. To Maryland, however, belongs the credit of being the first to undertake a topographic survey. It was stated at the time that one of the chief objects of establishing the Survey was to secure the cooperation of the Superintendent of the United States Coast and Geodetic Survey. Such a plan was perfected and subsequently carried out, evidently marking the beginning of the Federal and State cooperation in such matters which to-day prevails. Official reports and maps were issued by the Survey annually until 1842, when in February of that year the general assembly abolished the offices of engineer and geologist. A topographic map of the State had been made, on the scale of 1:200,000, with 50-foot contour lines to the east and 100-foot contour lines to the west of Monocacy River. This map, however, was never published, but a manuscript copy still exists. Special maps of certain portions of the State were also prepared, the most detailed being a topographic map of Dorchester, Somerset, and Worcester counties on the scale of 1:211,200, with 4-foot contour lines. The geologic publications of this first Survey consisted chiefly of county geologic reports, which embraced accounts of the physical geography, stratigraphy, mineral resources, and agricultural conditions. The reports were brief, but added much to the existing knowledge of the geology of the State.

No further official geologic work was attempted in Maryland until the general assembly, in March, 1848, authorized the governor to appoint a State agricultural chemist. Although the act authorized an examination of the mineral deposits, no attempt was made to carry out this provision of the act until the appointment of Philip T. Tyson in 1858. Mr. Tyson, who was much interested in geologic problems, published in his first report, which appeared in 1860, a geologic map of the State, on the scale of 12 miles to the inch, which was by far the most complete representation of Maryland's geology that had been attempted up to that time. In this report he dwelt upon the importance of a knowledge of the geologic formations of the State as a basis for the determination of the character of the soils as well as for all industrial operations. To the limestones and marls he gave special attention. In his second and last report, issued in 1862, just prior to the repeal of the act establishing the office of State agricultural chemist, he devoted much more attention to the mineral resources of the State than in his earlier report.

No further attempt at a systematic investigation of the geology of the State was made until the organization of the geologic department of Johns Hopkins University, in 1883, when Dr. George H. Williams began his connection with that institution as instructor in mineralogy. Dr. Williams devoted his attention particularly to a study of the crystalline rocks of the central portion of the State. In 1887 Dr. William Bullock Clark was added to the faculty of the university, as instructor in stratigraphic geology and paleontology, and he at once extended the geologic work to a study of the sedimentary formations of the eastern and southern portions of the State. The cooperation of the United States Geological Survey was secured, and Messrs. Williams and Clark were given appointments on the staff of the Federal Survey. Upon the death of Dr. Williams, in 1894, Dr. Edward B. Mathews was appointed to his position. Areal geology and special paleontologic and petrographic studies were continuously pursued until 1896, when the present State Geological Survey was organized, with Dr. Clark as State geologist and Dr. Mathews as assistant State geologist.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is designated the State Geological and Economic Survey; it was organized March 19, 1896.

SUMMARY OF LAWS.

An act to establish a State Geological and Economic Survey, and to make provision for the preparation and publication of reports and maps to illustrate the natural resources of the State, together with the necessary investigations preparatory thereto.[a]

SECTION 1. Be it enacted by the general assembly of Maryland, That there is hereby established a State Geological and Economic Survey which shall be under the direction of a commission composed of the governor, the comptroller, the president of the Johns Hopkins University, and the president of the Maryland Agricultural College, who shall serve without compensation, but shall be reimbursed for actual expenses incurred in the performance of their official duties; and the said commissioners shall have general charge of the Survey and shall appoint as superintendent of the same a geologist of established reputation, and upon his nomination such assistants and employees as they may deem necessary; and they shall also determine the compensation of all persons employed by the Survey, and may remove them at pleasure.

SEC. 2. And be it enacted, That the Survey shall have for its objects:

1. An examination of the geological formations of the State, with special reference to their economic products, viz, building stones, clays, ores, and other mineral substances.

[a] Laws of Maryland, 1896, chapter 51.

2. An examination and classification of the soils and a study of their adaptability to particular crops.

3. An examination of the physical features of the State with reference to their practical bearing upon the occupations of the people.

4. The preparation of special geological and economic maps to illustrate the resources of the State.

5. The preparation of special reports, with necessary illustrations and maps, which shall embrace both a general and detailed description of the geology and natural resources of the State.

6. The consideration of such other scientific and economic questions as in the judgment of the commissioners shall be deemed of value to the people of the State.

SEC. 3. And be it enacted, That the commissioners shall cause to be prepared a report to the legislature before each meeting of the same, showing the progress and condition of the Survey, together with such other information as they may deem necessary and useful or as the legislature may require.

SEC. 4. And be it enacted, That the regular and special reports of the Survey, with proper illustrations and maps, shall be printed as the commissioners may direct, and that the reports shall be distributed or sold by the said commissioners as the interests of the State and of science demand, and all moneys obtained by the sale of the reports shall be paid into the State treasury.

SEC. 5. And be it enacted, That all material collected, after having served the purposes of the Survey, shall be distributed by the commissioners to the educational institutions in such manner as to be of the greatest advantage to the educational interests of the State; or, if deemed advisable, the whole or a part of such material shall be put on permanent exhibition.

SEC. 6. And be it enacted, That the sum of $10,000 annually, or so much thereof as may be necessary, is hereby appropriated out of any funds of the treasury not otherwise appropriated, for the purpose of carrying out the provisions of this act.

SEC. 7. And be it further enacted, That this act shall take effect from the date of its passage.

The foregoing bill was introduced in the house January 9, 1896, was passed by that body February 18, by the senate March 11, and received the signature of the governor March 19.

Two years after the organization of the Survey additional legislation was obtained for the furtherance of topographic surveying and the publication of reports by the enactment of the following:

An act to provide for the making of topographic maps and for the publication of reports of the State Geological and Economic Survey, and to make an appropriation therefor.

[Laws of Maryland, 1898, chapter 129.]

SECTION 1. Be it enacted by the general assembly of Maryland, That the commission established by the act of the general assembly of Maryland at the session of 1896, chapter 51, be, and the same is hereby, authorized to make provision for the completion of the topographic survey of Maryland in such manner as in the opinion of the commission will be of the greatest benefit to the agricultural, industrial, geological, and military requirements of the State of Maryland.

SEC. 2. And be it further enacted, That the said commission be, and the same is hereby, authorized to publish special reports dealing with the various mineral products and with the natural resources of each county of the State of Maryland.

SEC. 3. And for the purpose of carrying out the provisions of this act be it further enacted, That the sum of $5,000 annually, in addition to the amount appropriated by the act of the general assembly of Maryland at the session of 1896, chapter 51, or so much thereof as may be necessary, be, and the same is hereby, appropriated out of any funds in the treasury not otherwise appropriated, and the said amount be drawn from the treasury by the said commission in the same manner as the other funds of the Survey.

SEC. 4. And be it further enacted, That this act shall take effect from the date of its passage.

The foregoing bill was introduced in the senate February 2, was passed by that body February 16, by the house March 17, and received the signature of the governor April 2.

For twelve years, from 1898 to 1910, the State Geological Survey maintained a highway division, but in 1910 the general assembly consolidated that division with a newly organized State Roads Commission. Under the act of 1898 an investigation of the roads and road-building materials of the State was undertaken, a testing laboratory was built, and advice was given by the engineers of the Survey to State, county, and municipal authorities. Under this act $10,000 was appropriated annually. In 1904, however, further legislation made available $400,000 annually from State and county funds for the construction of roads under the State Geological Survey, and in 1906 and 1908 special appropriations were made to the Survey for the construction of a road between Baltimore and Washington. Altogether about $2,000,000 was expended under the auspices of the Survey on road work, and the foundation was laid for the establishment of the present State Roads Commission, which has the expenditure of about $2,000,000 annually. Under the terms of the act establishing the Roads Commission, three out of its six members are appointed from the State Geological Survey, one of the three being State geologist. The influence of the Survey is thus being perpetuated, although the highway work is no longer carried on under its direct supervision.

ORGANIZATION.

The governing board is composed of the governor of the State, Austin L. Crothers; the State comptroller, William B. Claggett; the president of Johns Hopkins University, Ira Remsen; and the president of the Maryland Agricultural College, R. W. Silvester. These are all ex officio appointments. The members of the board receive no compensation beyond their expenses.

The executive officer is the State geologist. The present incumbent is Prof. William Bullock Clark, who has held the office since March

25, 1896. The State geologist is appointed by the governing board. His term of office is indeterminate. His compensation, which is on a per diem basis, is fixed by the board. Dr. Edward B. Mathews is assistant State geologist.

With the exception of a secretary, shipping clerk, and office boy, all the employees may be classed as geologic, as the topographic, hydrographic, magnetic, agricultural soil, meteorologic, and forestry work of the Survey is carried on in cooperation with other State organizations or with Federal bureaus, and those engaged in the work are for the most part employees of those bureaus.

The geologic assistants consist almost exclusively of instructors and graduate students in geology at Johns Hopkins University. The compensation is entirely on the per diem basis and varies with the ability of the workers to furnish results of value to the Survey. The number employed varies with the season of the year, but from 12 to 15 are annually on the rolls for longer or shorter periods. No civil-service examinations are required, and the appointments are left to the State geologist, subject to the approval of the board.

APPROPRIATIONS.

The appropriations are continuing and are not contingent on cooperation. All unexpended balances are carried to the next fiscal year and do not lapse to the State treasury. The annual appropriation is $15,000. Fully 90 per cent is devoted to geologic and topographic surveys, paleontologic studies, and publication. The remainder is devoted to special investigations. The topographic survey of the State is now nearly completed, and although conducted on behalf of the State, under the direction of the State geologist, the expense has been shared by the highway division of the State Geological Survey, the State Weather Service, and the State Forestry Bureau, of all of which the State geologist has also been the executive officer.

PUBLICATIONS.

The publications of the present State Survey comprise volumes 1 to 9 of general reports, 3 volumes of systematic geology and paleontology (Eocene, Miocene, and Pliocene-Pleistocene), 6 volumes of county reports (Allegany, Garrett, Cecil, St. Marys, Calvert, and Prince Georges counties), a guide to the State mineral exhibit, 3 State maps (on scales of 8, 5, and 3 miles to the inch), 18 county maps (scale 1 mile to the inch), and a map of Baltimore and vicinity. The size of the edition has varied from 1,500 for the county reports and the volumes of systematic geology and paleontology to 2,500 for the general reports and 5,000 for the guide to the mineral exhibit. The maps are usually published in editions of 5,000 each.

The cost of printing reports and maps is defrayed from the Survey appropriation and varies widely from year to year. The Survey has full control of all matters connected with the printing of maps and reports. No limitations of any kind exist. The Survey also has full control over the distribution of reports and maps, which are sent to all leading libraries, scientific societies, and many prominent geologists both at home and abroad. An extensive exchange has been established.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

The Survey is engaged independently in a study of the geology of the State, including primarily stratigraphy, paleontology, and mineral resources. The geologic formations are being mapped as fast as the topographic base maps are completed. These are on a scale of 1 mile to the inch. Special monographs dealing with the systematic geology and paleontology of the State are likewise being prepared. In addition to the volumes on the Eocene, Miocene, Pliocene, and Pleistocene already issued, manuscripts are nearly completed for the Devonian, Upper Cretaceous, and Lower Cretaceous. Special economic studies of the building stones, coals, clays, and limestones have already been published and a manuscript on iron ores is now in press.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—The State Geological Survey cooperates with the United States Geological Survey in its topographic work, in certain areal geologic surveys in the central portion of the State, and in the collection of mineral statistics. Special cooperation has also been undertaken in connection with some of the paleontologic studies. Preliminary arrangements have also been made for a study of the swamps adjoining Chesapeake Bay.

Other departments of the National Government.—For many years cooperation has been maintained with the United States Bureau of Soils and the United States Coast and Geodetic Survey. The cooperation with the Soils Bureau has been in the preparation of agricultural soil maps of the several counties, with accompanying descriptive texts, which have been incorporated in the county reports. The cooperation with the United States Coast and Geodetic Survey has been in the establishment of North-South lines at the county seats and in the preparation of reports on the terrestrial magnetism of the State, which have been published in the general reports and the county reports. This work is now being done under the auspices of the Carnegie Institution of Washington. Cooperation was main-

tained for several years with the United States Forest Service, but this work is now carried on through the medium of the State board of forestry.

Other State geological surveys.—No direct cooperation has been undertaken with other State geological surveys, although close affiliation has been maintained with the surveys of Virginia and North Carolina, especially in the study of the deposits of the Coastal Plain.

Other State scientific bureaus.—Cooperation is maintained with the State Weather Service in the preparation of reports on the climate of the State, which have been issued in the county reports, and with the State Board of Forestry in the preparation of maps and reports on the forests of the various counties.

MICHIGAN.

PREVIOUS SURVEYS.

The first State Geological Survey of Michigan was organized in 1837, the act establishing it carrying an appropriation of $3,000 for the first year. During the three succeeding years annual appropriations of $6,000, $8,000, and $12,000, respectively, were made to carry on the work. Douglass Houghton was State geologist during the life of the first Survey. The results of the work are contained in five annual reports, the last bearing the date of 1842, all of which were published in the State senate and house documents. At the end of the fourth year no further provision for the Survey was made and the work ceased.

Geologic work in Michigan was resumed in 1859, when the second Geological Survey was organized, under the direction of Prof. Alexander Winchell, but this was quickly interrupted by the outbreak of the civil war. The only publication was a first biennial report of progress, which was issued in 1861.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the Michigan Geological and Biological Survey; it was organized under the law of 1869, which was slightly modified in 1905.

HISTORICAL SKETCH.

By act of the State legislature of 1869, which continues in force to the present time, the board of geological survey, consisting of the governor, the superintendent of public instruction, and the president of the board of education, was constituted. This board was authorized to "supervise the continuance and completion of the

geological survey of the State, and for that purpose they may, from time to time, appoint such person or persons to assist in making said survey as may be deemed necessary."

The first executive officer under this act was Alexander Winchell, who on April 24, 1869, was appointed "director of the Geological Survey of Michigan." The following year the director was authorized to employ Prof. Raphael Pumpelly "to take charge and conduct a survey of the copper regions."

In 1871 Prof. Winchell resigned and Carl Rominger was appointed to make a survey of the Lower Peninsula and of the eastern part of the Upper Peninsula during the years 1871 and 1872, and Maj. T. B. Brooks was engaged to continue a survey of the iron regions during the same period.

In 1872 a contract was awarded for the publication of 200 copies of volume 1 of the State Survey reports. This was the first of the series generally known as the "large green volumes," the publication of which was discontinued with volume 9, issued in 1902.

During the year 1873 Dr. Rominger, with two field parties, investigated the coal beds of the State. During the following year Rominger's investigations were confined more especially to timber, soil, water supply, elevations, etc., with a view to making popular reports on these subjects.

In 1885 Charles E. Wright was appointed State geologist for one year, beginning March 1. Subsequently he was reappointed and held the position until the spring of 1888, when he was succeeded by M. E. Wadsworth, who held the office until July 1, 1893. Mr. Wadsworth was followed by Dr. L. L. Hubbard, who served as State geologist until his resignation in 1899, when Dr. Alfred C. Lane, who had been assistant State geologist during Hubbard's entire term of office, was appointed to fill the position. Dr. Lane continued as State geologist until September 1, 1909, when he resigned, and R. C. Allen, the present incumbent, was appointed to the office.

SUMMARY OF LAWS.

The purpose for which the Survey was established, as stated in the act creating it, is as follows:

It shall be the duty of said board to make, or cause to be made, a thorough geological and mineralogical survey of the State, embracing a determination of the succession and arrangement, thickness, and position of all strata and rocks, their mineral character and contents, and their economical uses; an investigation of soils and subsoils, and the determination of their character and agricultural adaptation; the investigation of all deposits of brines, coal, marl, clay, gypsum, lime, petroleum, and metals and metallic ores, building stone, marble, gritstone, materials for mortar and cement, mineral paint, and all other productions of the geological world within the limits of the State, capable of being converted to the uses of man.

It shall be the duty of said board to furnish an annual report of the progress of the survey, and as often as possible a condensed statement of important and interesting facts for general circulation.

To carry into effect the provisions of the act above quoted the sum of $8,000 was appropriated annually until the completion of the survey, no part of the appropriation to be used for the printing of reports.

In 1905 the legislature extended the functions of the board of geological survey by directing it to make, under the general direction of the State geologist appointed by the board, "a thorough biological survey of the State, embracing a determination of the range and distribution of the various plants and animals inhabiting the State and the relation to their environment and the welfare of man." This act carried an annual appropriation of $1,000 for two years, for the purpose of making the biologic survey, and this appropriation was renewed by the sessions of 1907 and 1909. The act provides that no part of the appropriation shall be used for the printing of reports.

ORGANIZATION.

By the act of 1869 the governing board is called board of geological survey and is composed of the governor, the superintendent of public instruction, and the president of the board of education, who serve ex officio. At present the personnel of the board is as follows: President, Hon. Chase S. Osborn, governor of the State; vice president, Hon. D. M. Ferry, president of State Board of Education; secretary, Hon. L. L. Wright, superintendent of public instruction. The members of the board do not receive compensation for their services.

The board is empowered to engage such persons as it may deem wise, without civil-service intervention, and to fix the compensation of employees. The term of office of the director (State geologist) is indefinite. He receives an annual salary.

The present staff of the Survey consists of the director, an assistant geologist, a chief field naturalist (in charge of biologic survey), and a secretary. R. C. Allen is the director. College professors and advanced students are given temporary positions in the field during the field season, and occasionally the students are employed in drafting and other office work.

APPROPRIATIONS.

Under the law of 1869 the sum of $8,000 is appropriated annually until the completion of the work of the Survey. In addition, the legislatures of 1905, 1907, and 1909 appropriated $1,000 annually for the biologic work of the Survey, and during the last decade various amounts, averaging about $2,000 annually, have been appropriated

for cooperation with the United States Geological Survey in the preparation of topographic maps.

Unexpended balances lapse to the State treasury at the end of the fiscal year (June 30), but bills contracted before that date will be paid from unexpended balances up to December 15.

About 50 per cent of the general appropriation ($8,000) is expended for administrative work. The remainder is used for geologic field work, traveling expenses, office incidentals, etc.

The appropriation for cooperative topographic work is expended mainly in field work.

Of the $1,000 apropriated annually for the biologic survey, the chief field naturalist receives an annual salary of $400; the remainder is expended in field work, including salaries of assistants.

PUBLICATIONS.

Since the organization of the present Survey in 1869 a large number of publications have been issued. These include two brief progress reports (published in 1869 and 1871); a series of detailed reports on the general and economic geology of the State, comprising volumes 1 to 9, inclusive, published between 1873 and 1902; a series of annual reports, comprising 12 volumes; two annual reports devoted to the work of the biologic survey; and publications 1, 2, and 3 of a new series. These publications include reports, of both a general and a detailed nature, on the areal, stratigraphic, economic, and paleontologic geology of different sections of the State, or of the State as a whole.

The board of geological survey has full control over the distribution of reports. Publications are sent to educational institutions in the State without charge, and to individuals, for purposes of instruction, on receipt of transportation charges. To nonresidents a regular charge is made. All moneys received from the sale of reports are paid into the State treasury.

The printing of all reports is executed by the State printer, who holds a two-year contract for all State work. The cost of printing is paid from a general fund and does not come out of the Survey appropriation.

PRESENT LINES OF WORK.

Independent investigations.—At present the Survey is primarily engaged in an investigation of the salt industry of the State, and in geologic surveys of the Huronian areas in the Northern Peninsula and of the copper district. The biologic work of the present season will consist of a botanical survey of the peach belt of western Michigan.

Cooperation with the United States Geological Survey.—The topographic survey of the State is conducted in cooperation with the Federal Survey, with a *joint appropriation* of $4,000,

MINNESOTA.

HISTORICAL SUMMARY.

The Minnesota State legislature of 1872 passed an act creating the Geological and Natural History Survey, and for 33 years the work of this organization was prosecuted with varying vigor and support. This law, which was drawn by President William Watts Folwell, of the University of Minnesota, was very comprehensive in its scope. It provided for explorations in geology, geography, archeology, zoology, botany, and topography, the preparation of a map of the State, and the establishment of a geologic and natural history museum. In fact, it provided for one of the most comprehensive surveys that was ever organized in this or any other country, but since the establishment of this Survey many other surveys of equally wide scope have been established. The law creating this survey read as follows:

SECTION 1. It shall be the duty of the board of regents of the University of Minnesota to cause to be begun as soon as may be practicable, and to carry on, a thorough geological and natural history survey of the State.

SEC. 2. The geological survey shall be carried on with a view to a complete account of the mineral kingdom, as represented in the State, including the number, order, dip, and magnitude of the several geological strata; their richness in ores, coals, peats, clays, salines and mineral waters, marls, cements, building stones, and other useful materials; the value of said substances for economical purposes, and their accessibility; also an accurate chemical analysis of the various rocks, soils, ores, clays, peats, marls, and other mineral substances, of which complete and exact record shall be made.

SEC. 3. The natural-history survey shall include, first, an examination of the vegetable productions of the State, embracing all trees, shrubs, herbs, and grasses, native or naturalized in the State; second, a complete and scientific account of the animal kingdom, as properly represented in the State, including all mammals, fishes, reptiles, birds, and insects.

SEC. 4. The said surveys and examinations shall be made in the manner and order following: First, the geological survey proper, together with the necessary and implied mineralogical investigations, all of which shall be undertaken as soon as may be practicable and be carried forward with such expedition as may be consistent with economy and thoroughness; second, the botanical examinations; third, the zoological investigations: Provided, however, That whenever the said board of regents may find it most economical to prosecute different portions of the surveys in conjunction, or that the public interest demands it, they may, in their discretion, depart from the above-prescribed order. And in the employment of assistants in the said surveys, the board of regents shall at all times give the preference to the students and graduates of the University of Minnesota, provided the same be well qualified for the duties.

SEC. 5. The said board of regents shall also cause to be collected and tabulated such meteorological statistics as may be needed to account for the varieties of climate in the various parts of the State; also to cause to be ascertained [by] barometrical observations or other appropriate means the relative elevations and depressions of the different parts of the State; and also, on or before the completion of the said surveys, to cause to be compiled from such actual surveys and measurements as may be necessary, an accurate map of the State,

which map, when approved by the governor, shall be the official map of the State.

SEC. 6. It shall be the duty of said board of regents to cause proper specimens, skillfully prepared, secured, and labeled, of all rocks, soils, ores, coals, fossils, cements, building stones, plants, woods, skins, and skeletons of animals, birds, insects, and fishes, and other mineral, vegetable, and animal substances and organisms discovered or examined in the course of said surveys to be preserved for public inspection free of cost in the University of Minnesota, in rooms convenient of access and properly warmed, lighted, ventilated, and furnished and in charge of a proper scientific curator; and they shall also, whenever the same may be practicable, cause duplicates in reasonable numbers and quantities of the above-named specimens to be collected and preserved for the purpose of exchanges with other State universities and scientific institutions, of which latter the Smithsonian Institution at Washington shall have the preference.

SEC. 7. The said board of regents shall cause a geological map of the State to be made as soon as may be practicable, upon which, by colors and other appropriate means and devices, the various geological formations shall be represented.

SEC. 8. It shall be the duty of the said board of regents, through their president, to make, on or before the second Tuesday in December in each and every year, a report showing the progress of the said surveys, accompanied by such maps, drawings, and specifications as may be necessary and proper to exemplify the same to the governor, who shall lay the same before the legislature; and the said board of regents, upon the completion of any separate portion of the said surveys, shall cause to be prepared a memoir or final report, which shall embody in a convenient manner all useful and important information accumulated in the course of the investigation of the particular department or portion; which report or memoir shall likewise be communicated through the governor to the legislature.

SEC. 9. To carry out the provisions of this act the sum of $1,000 per annum is hereby appropriated, to be drawn and expended by the [said] board of regents of the University of Minnesota.

SEC. 10. This act shall take effect and be in force from and after its approval.

After the passage of this act and its approval by Governor Austin in 1872, Newton H. Winchell was appointed State geologist. For 28 years, or until the year 1900, the survey was prosecuted vigorously under his direction, and it proved to be one of the most successful investigations ever undertaken in the State. The publications comprised 24 volumes of annual reports, giving from year to year a statement of the work carried on in the prosecution of the survey; 10 bulletins, published at different times, giving special results of explorations; and a final report, consisting of five volumes of text and one volume of maps, giving a summary of the information gained for the benefit of the Commonwealth.

In 1873 the legislature enacted a supplementary law, under which certain State lands, known as State salt lands, were assigned to the board of regents, the money derived from the sale of the lands to be disbursed by the board of regents in accordance with the law author-

izing the Geological and Natural History Survey of the State. This law also increased the annual appropriation for the maintenance of the Survey from $1,000 to $2,000 annually.

In 1900 the geologic work under the Geological and Natural History Survey was formally discontinued, but the botanical and zoologic work was continued for a number of years, under varying appropriations. Occasional geologic explorations were also authorized. These were placed under the direction of Prof. C. W. Hall, who up to the present time has continued to look after the collections of the Survey and to attend to the geologic correspondence.

In 1905, by the codification of the laws of the State, the act creating the Geological and Natural History Survey was abolished, thereby blotting out the legislation under which scientific explorations had been conducted for 33 years. The funds which had accumulated from the sale of salt spring lands were, however, left in the hands of the board of regents, to be used by them in scientific explorations. Although the amount of these funds is not large, it has been most helpful in aiding scientific work along the original lines of the survey, particularly zoologic and botanic research.

During the many years of prosecution of field work by the Survey a vast amount of geologic material was gathered for the laboratory investigations incident to the preparation of reports. Under the law this material was to belong to the scientific museum, which the board of regents was authorized to build up. Owing to a lack of funds and the growth of the university it has not been possible to put this material in the shape of a useful, practical museum, but it is stored for use as soon as the resources of the regents shall permit them to give the space required for its display.

MISSISSIPPI.

PREVIOUS SURVEYS.

An act of the legislature of Mississippi entitled "An act to further endow the University of Mississippi," approved March 5, 1850, was the first authorization of a geologic survey of the State. Under this law the trustees of the university elected Dr. John Millington, at that time professor of natural sciences at that institution, as the first State geologist and B. L. C. Wailes as assistant State geologist.

This first survey was not only a geologic and agricultural survey, but contemplated a complete biologic survey of the State as well. Dr. Millington was too old to do active field work, and the prosecution of the survey fell principally upon Prof. Wailes. Much work of a reconnoissance character was done by Prof. Wailes in an effort to unfold the geologic structure of the State, large collections of specimens were made, and a State museum was established. The

fossils collected were chiefly from the Jackson and Vicksburg formations and were determined by T. A. Conrad. When the report was ready for publication in 1854 it embodied so largely the results of Prof. Wailes's work that Dr. Millington thought that to publish it under his own name would be an injustice to his coworker. His recommendation that it be published in Wailes's name was adopted, and the publication is known as "Wailes's report on agriculture and geology of Mississippi."

In 1854 Lewis Harper succeeded Wailes as State geologist and Eugene W. Hilgard was appointed assistant State geologist. During the next three years the work of the Survey was carried on by these men, chief attention being given to the economic aspects of the investigations. The results are embodied in a report on the agriculture and geology of Mississippi published in 1857.

In 1857 Hilgard succeeded Harper as State geologist. He was preeminently well qualified for the work. Educated in Germany, he had thorough and special training in chemistry and agricultural science, besides being an accomplished geologist. He studied the geologic structure of the State and the economic products and soils thoroughly and accurately. He made large and valuable collections of specimens, which are now in the cabinets of the State University.

As a result of his studies, Hilgard in 1860 published a most creditable report on the geology and agriculture of Mississippi. The civil war broke out before the reports were received from the St. Louis publisher, and not until after the close of the war were they put into circulation.

During the civil war appropriations for the Survey stopped, except the $1,200 salary of the State geologist, which, though small, was continued in appreciation of the valuable services which Dr. Hilgard had given the State.

After the close of the war, owing to the general financial depression, no further appropriations for the geologic survey were made, though Hilgard continued to serve as State geologist until 1869, being assisted by Eugene A. Smith and R. H. Loughridge. In 1869 Hilgard resigned his work in Mississippi and went to Michigan. He was succeeded as State geologist by Dr. George Little, of Alabama, who was assisted by E. A. Smith. Though valuable field notes were collected by Drs. Little and Smith, no reports were published by them. The Survey lacked financial support and died a natural death.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the Geologic, Economic, and Topographic Survey of Mississippi; it was created by act of legislature of March, 1906. A. F. Crider was director from 1906 to 1909.

SUMMARY OF LAWS.

The objects of the Survey as embodied in the act are as follows: To examine the economic natural resources of the State; to prepare a topographic map of the State; to examine and classify the soils of the State; to investigate the water resources of the State; to examine and report on road-making materials of the State; to examine the physical features of the State in their relations to the occupations of the people; to prepare such other special geologic reports as may be necessary; and to consider any other kindred scientific and economic questions.

In May and November of each year the geological commission meets and receives the report of the Director of the Survey. The commission in turn is required to report to the legislature at each regular and special session the progress of the work of the Survey.

The geological commission has general supervision of the work of the Survey in administrative matters; but the technical details of the work, the assignment of work to assistants, and the supervision of that work are left to the director of the Survey.

Persons engaged in the work of the Survey are privileged to enter upon and investigate any lands within the State and are protected by law in the performance of their official duties.

ORGANIZATION.

The governing board is the geological commission, consisting of five members—the governor of the State, the State superintendent of education, the director of archives and history, the chancellor of the State University, and the president of the State Agricultural and Mechanical College. These officers are ex officio members of the commission and serve during the tenure of their respective offices. With the exception of the secretary of the commission, who receives $25 a month, the members receive no compensation for their services.

The executive officer is designated director of the State Geological Survey. The present incumbent is E. N. Lowe, who was appointed by the commission June 4, 1909. The director can not hold any other office and is required to give his whole time to the work of the Survey. His term of office is not limited. He is paid an annual salary, which is fixed by the commission.

The following subordinates are employed: One clerk and four geologic and other assistants. One university professor and two advanced students have been employed by the Survey during the present year.

APPROPRIATIONS.

Appropriations are biennial and are not contingent upon cooperation. Unexpended balances revert to the State treasury immediately on the expiration of the year. The annual appropriation is $8,000,

of which $2,000 is for salary of director and $6,000 for salaries of assistants and expenses. The expenditures are made in about the following proportions:

	Per cent.
Administrative and routine clerical work	15
Economic, stratigraphic, and areal geology and underground water resources	28
Chemistry	2
Soil survey	55

Clerical assistance in the office is limited to the summer season, when the director is much of the time in the field. The soil survey is continued throughout the year, but all other field work is largely cut down during the winter.

PUBLICATIONS.

All publications of the Survey are in the form of bulletins. Eight of these have thus far been published, in editions of 2,000 copies each.

For the first three years the cost of printing averaged $1,665 a year and was paid out of the State printing fund. In March, 1910, a geologic printing fund of $1,000 a year was provided.

The Survey has absolute freedom as regards printing, except choice of printer. The State printer does the printing for the Survey under a general contract with the State.

The Survey has entire control of the distribution of reports. They are sent free, aside from postage, to intelligent citizens all over the State, to the related departments of the State government, to the higher educational institutions in the State, to the United States Geological Survey and related departments at Washington, to all State surveys which desire to exchange, to all geologists expressing a desire for them, to the higher educational institutions of the country, to public libraries, and to foreign geological surveys desiring to exchange.

PRESENT LINES OF WORK.

Independent investigations.—The Survey is at present engaged primarily in an investigation of structural materials in the State and in a study of the soils with special reference to erosion and the methods of preventing it.

Cooperation with United States Geological Survey.—Cooperation is maintained with the Federal Survey in the study of the Coastal Plain deposits of Mississippi and the water resources of the State.

Cooperation with United States Bureau of Soils.—In cooperation with the Bureau of Soils of the United States Department of Agriculture, a classification of the soils of the State is in progress, the

basis of cooperation being that each bureau shall furnish the same number of men, and each field party shall consist of one man from the Federal Bureau and one man from the State Survey.

MISSOURI.

PREVIOUS SURVEYS.

FIRST GEOLOGICAL SURVEY.

The act creating the first Geological Survey of Missouri was approved by the governor February 24, 1853. Under this act the governor was authorized to appoint a State geologist, who, with assistants, was to make a thorough geologic and mineralogical survey of the State. Prof. G. C. Swallow, of Maine, was appointed to the position, and organized the department the same year. Under his direction the Survey continued active operations until 1861, when it was discontinued because of the civil war.

The publications of the first Survey consisted of the "First and second annual reports," published in 1855 as one volume divided into two parts, part 1 containing 207 pages and part 2 containing 240 pages; the third, fourth, and fifth progress reports, consisting of small brochures; and a special report of 93 pages, published in 1859. entitled "Geological report of the country along the line of the Southwest Pacific Railroad, State of Missouri."

SECOND GEOLOGICAL SURVEY.

The second Geological Survey was created in May, 1870, by the passage and approval of an act which established a "Mining, Metallurgical, and Geological Bureau," with headquarters at St. Louis. By this act the governor was authorized to appoint a governing board, consisting of one member from each congressional district. This board appointed Albert D. Hager to the position of State geologist. Mr. Hager resigned in August, 1871, when Dr. J. G. Norwood was placed in temporary charge. On November 25, of that year, Raphael Pumpelly was appointed State geologist. He served until May, 1872, when, on his resignation, Prof. G. C. Broadhead was appointed to the office. Prof. Broadhead resigned in 1874, when the instruments and records of the Survey were moved to Rolla, Mo., and placed in charge of Prof. Charles Williams, who was made acting director. The second Survey was abolished in 1876.

The publications of the second Survey consisted of a volume of county reports (324 pages) covering work done between 1855 and 1871; Hager's annual report (23 pages), published in 1871; Pumpelly's report (655 pages and atlas), published in 1872; Broadhead's report (734 pages), published in 1874; and Williams's report (177 pages), published in 1876.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the Bureau of Geology and Mines; it was organized under an act approved May 13, 1889.

HISTORICAL SKETCH.

By the provisions of the act of May 13, 1889, the organization and direction of the work of the Bureau are under the supervision of the board of managers, consisting of the governor, who is ex officio president of the board, and four members appointed by the governor from the State at large. On August 29, 1889, Arthur Winslow was appointed director and State geologist, and he served until 1894. On his resignation Prof. C. R. Keyes was appointed to the position, and he served until 1897. On his resignation Dr. John Gallaher, of Warrensburg, was appointed, and he served until his death, which occurred July 21, 1900, when his son, Leo Gallaher, was made acting State geologist. In September, 1901, Dr. E. R. Buckley was appointed director and State geologist. He resigned in May, 1908, at which time he was succeeded by H. A. Buehler, the present incumbent.

SUMMARY OF LAWS AND ORGANIZATION.

As stated above, the work of the Bureau is under the supervision of the board of managers, the members of which are appointed for a term of four years and receive no compensation other than traveling expenses.

The executive officer under whose supervision the work of the Survey is performed is called director and State geologist. He is appointed by the board and serves until his successor is chosen. The appointment and removal of assistants are optional with the director and are without civil-service restrictions. The salary of the director is fixed by law at "not to exceed $3,000," and the salary of the assistant State geologist at "not to exceed $1,800." The salaries of the remaining employees are regulated by the board of managers.

The director and from three to five assistants devote their entire time to the work of the Bureau. Usually several temporary assistants are employed during the field season. At present only a small proportion of the work is performed by college professors or advanced students. A chemist and a draftsman are employed continuously, and a stenographic clerk has charge of the office work. Additional office assistants are employed from time to time as required.

APPROPRIATIONS.

The Bureau receives a biennial appropriation, which is not conditional upon cooperation. If the entire appropriation is not expended during the biennial period the sum remaining reverts at once to the State treasury. The appropriation during the present biennium is $12,500 annually for geology and $5,000 annually for topography.

The appropriation is expended approximately as follows:

	Per cent.
Administration	15
Topographic surveys	30
Economic and stratigraphic geology	35
Statistics	2
Chemistry	5
Miscellaneous	3
Publications	10–20

PUBLICATIONS.

The publications of the present Geological Survey of Missouri comprise a first series of geologic reports numbering 13 volumes, a second series of geologic reports numbering 9 volumes, and a series of biennial progress reports submitted by the director to the board of managers and by the board transmitted to the legislature. The geologic reports are chiefly of an economic nature, but include several county reports, two volumes on the paleontology of Missouri, two volumes on the areal geology, and one volume on the surface features of the State. The edition of the geologic reports is usually 3,000 copies. The cost of printing is paid out of the Survey appropriation.

All manuscripts are submitted to a publication committee, consisting of two members of the board of managers. After receiving their approval the reports are published under the direct supervision of the State geologist. The printing is done by the State printer.

PRESENT LINES OF WORK.

During the present biennial period the Bureau has the following investigations under way:

Independent investigations.—A study of the iron ores of the State, geologic mapping in Jackson County, a study of the Aurora lead and zinc area, reconnoissance work along the southern boundary of the State, and geologic mapping in Phelps County.

Cooperation with the United States Geological Survey.—The Bureau is cooperating with the Federal Survey in a study of the "Coal Measures," in statistical work covering mineral production, in the collection of deep-well records, and in topographic mapping.

NEBRASKA.

HISTORICAL SKETCH.

The first attempt to establish a Geological Survey in Nebraska was made in 1891, when the present State geologist, Edwin H. Barbour, who had recently become a resident of the State, was appointed State geologist by Gov. Thayer. The appointment was purely an honorary one, there being no funds available for the payment of either salary or expenses. The newly appointed State geologist therefore defrayed his own expenses the first year. In 1892 the Hon. Charles H. Morrill proffered an annual allowance of $1,000 for the maintenance of geologic work in the State.

In 1893 the State legislature enacted that the head professor of geology in the University of Nebraska should be the State geologist, without stipend.

In 1899 the board of regents of the University of Nebraska, in recognition of the importance of a Geological Survey, provided that $500 should be devoted to the work during 1899 and $250 annually during 1900, 1901, and 1902.

In 1901 the legislature made the first appropriation for the Survey, the sum of $1,200 being allotted for the biennium of 1901 and 1902. Since that time the legislature has, at the request of the State geologist, made the following additional appropriations to carry on the work of the Survey: 1903–4, $2,000; 1905–6, $2,000; 1907–8, $2,500; 1909–10, $2,500. For the biennium of 1911 and 1912 the sum of $10,000 has been requested. Unexpended balances lapse to the State treasury on August 1 following the close of a biennium, which is March 31.

The Nebraska Geological Survey has no governing board. The executive officer is the State geologist, who has direct supervision over the Survey, employing such help as he can within the scope of the appropriations.

As Nebraska is a distinctly agricultural State, with no mines and few mineral resources, it has enacted no mining and geologic laws.

PUBLICATIONS.

The publications of the Survey consist of four volumes and comprise one report on the general geology of the State, one county report, five economic reports, eleven paleontologic papers, and two papers on prehistoric man in Nebraska. Several manuscripts are awaiting publication. The editions of the reports are limited to 1,000 copies.

Bids for printing are advertised for by the State printing board and the contract is let to the lowest bidder, but the director of the Survey specifies kind of paper, type, binding, etc.

Two hundred copies of each report are filed with the State librarian for exchange and distribution; the others are distributed by the Survey to institutions gratuitously and to individuals on the payment of postage.

PRESENT LINES OF WORK.

Independent investigations.—During the past season men and teams were employed and the first attempt at detailed geologic work was made. The stratigraphy of five counties was worked out with considerable minuteness. This work is to be vigorously continued during the season of 1911. A separate report will be devoted to each county.

Cooperation with United States Geological Survey.—The topographic work which the United States Geological Survey has done in this State has covered only about a third of the area, and it is the purpose of the State geologist during the next biennium to benefit as far as means will allow by cooperation with the Federal Survey.

NEW JERSEY.

PREVIOUS SURVEYS.

ROGERS SURVEY, 1835–1840.

The first geologic survey of New Jersey, commonly known as the Rogers survey, was authorized by act of the legislature dated February 26, 1835. Henry D. Rogers, professor of geology in the University of Pennsylvania, was appointed to make the survey. Reports of progress were presented in 1836, 1837, and 1838, and a final report was published in 1840, the latter an octavo volume of 301 pages, with a geologic map of the State on a scale of 6 miles to the inch and two cross sections. The more important geologic periods were recognized and their formations mapped and described, emphasis being given to the economic products. The total amount appropriated was $5,000, and the work of the survey terminated with the submission of the final report.

KITCHELL SURVEY, 1854–1856.

In January, 1854, Gov. R. M. Price recommended that a thorough geologic survey of the State be authorized. This was done in March of the same year, and Dr. William Kitchell was appointed superintendent and State geologist, Dr. George H. Cook assistant geologist, Dr. Henry Wurtz chemist and mineralogist, and Gen. E. L. Viele topographic engineer. The law provided for a thorough geologic survey by townships, with county reports. Work was carried on in 1854, 1855, and 1856, and annual reports for those years, also a report

on the geology of Cape May County, were published. Good progress had been made, particularly in determining the distribution and character of the iron ores, green-sand marl, and clay deposits, and more or less topographic work had been completed in 8 of the 21 counties of the State, when the work was suspended. A total of $49,000 was appropriated during these three years, but owing to the poor condition of the State's finances only a portion of this was ever available and the survey died of financial starvation, leaving much work in an unfinished condition.

In 1860 the State Agricultural Society secured the passage of an act by which Dr. Kitchell was allowed free use of all material and data collected by his survey, for the purpose of publishing a final report and map at his own financial risk. Owing to Dr. Kitchell's death in 1861 nothing resulted from this legislation.

In 1863 the same society secured the passage of a law authorizing its officers to receive all the survey material and data, which were to be transferred to Dr. George H. Cook or some other suitable person, with a view of completing the survey as contemplated in the agreement with Dr. Kitchell. Under this authorization some work was done in 1863, with results so satisfactory that in 1864 Dr. Cook persuaded the legislature to establish a new Survey, which has since been continuously maintained.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The title of the present organization is Geological Survey of New Jersey; it was established by act of the legislature in March, 1864.

HISTORICAL SKETCH.

In the law establishing the Geological Survey of New Jersey Dr. George H. Cook was named as State geologist. Dr. Cook continued in that office until his death in 1889. In 1890 Dr. John C. Smock, who since 1864 had been almost continually associated with Dr. Cook in the work of the Survey, was made State geologist. He resigned in 1901, and was succeeded by Dr. Henry B. Kümmel, who had been connected with the Survey since 1892. At first it was contemplated that the work of the Survey would be completed in four years, and it was so specified in the act of 1864. This clause, however, was soon repealed, and by successive acts, passed at five-year intervals, financial support was provided for the Survey until 1895. Since that time an appropriation for the Survey has each year been made in the regular appropriation bill.

SUMMARY OF LAWS.

The original act has been so extended and modified from time to time by amendment and supplement that the legal provisions under which the Survey is conducted can be better understood from a summary than from the quotation of statutes. The law recognizes "the duty of the State to develop and render available to the fullest extent the facts relative to its great natural resources, as also of its agricultural, mining, mechanical, and other industrial interests," and it places upon the Survey the carrying out of this duty.

There is a board of managers, composed originally of two from each congressional district, but now of one from each congressional district (of which there are 10) and not more than 10 from the State at large. The board was formerly self-perpetuating, but its members are now appointed by the governor, who is ex officio president of the board, and are confirmed by the senate, for terms of five years each, not more than four being appointed each year. The board has power (1) to appoint the State geologist and to fix his salary, (2) to fix the salaries of his permanent assistants, (3) to approve for publication all reports submitted and direct the distribution, by sale or otherwise, of reports, maps, and suites of specimens, and (4) "on the application of at least five owners of separate lots of land included in any tract of land in this State which is subject to overflow from freshets, or which is usually in a low, marshy, boggy, or wet condition," to examine such tracts, and, if deemed for the public interest, to survey and make a plan for their drainage, which plan is to be submitted to the supreme court, with a request for the appointment of commissioners to carry out and execute the works of drainage and to assess, collect, and pay the expenses incurred. In practice the board of managers is chiefly an advisory body, the general direction and the details of management of the Survey being left to the State geologist.

The State geologist has by law authority (1) to appoint assistants (subject to the provisions of a later-enacted civil-service law); (2) to fix salaries of temporary assistants, to purchase necessary instruments, supplies, and materials, and to direct all incidental expenditures; (3) to enter, with his assistants, without molestation, upon all lands in the State to further the objects of the Survey; and (4) to prepare or cause to be prepared both administrative reports and scientific reports and maps on subjects pertinent to the work of the Survey. By custom he has authority in all matters relating to the Survey not specifically reserved by law to the board of managers. From time to time the legislature has directed the State geologist to make special surveys of various kinds, such as of forestry conditions in the State and routes for inland waterways.

ORGANIZATION.

The governing body is the board of managers, made up as stated under "Summary of laws." Apart from their power to appoint the State geologist, fix salaries, and, through a committee, audit all expenditures, their duties are chiefly advisory. Regular meetings are held twice a year; special meetings when required. Members of the board receive no compensation but are reimbursed for expenses incurred in attending meetings.

The State geologist is appointed by the board of managers, subject to the approval of the governor, and holds office at the pleasure of the board. He is by law ex officio executive officer of the forest commission of New Jersey and gives considerable attention to the direction of that work but receives no extra compensation therefor. He is not at liberty to undertake outside professional work or to hold other positions. The present State geologist, Henry B. Kümmel, was appointed January 1, 1902, and is the third to hold that office since the establishment of the Survey in 1864. His compensation is an annual salary, fixed by the board of managers and paid in monthly installments.

The headquarters of the Survey are in the capitol building at Trenton, N. J.

There are two clerical assistants, who are appointed by the State geologist from eligible lists furnished by the State civil service commission. They are employed continuously and are subject to removal by the State geologist at any time and for any cause except politics or religion. Their compensation ranges from $40 to $75 a month.

One geologic assistant and one chemist are continuously employed, and temporary geologic assistants are engaged from time to time on a per diem basis. The temporary assistants are chiefly instructors and professors in geology in colleges and universities. The monthly compensation of these assistants ranges from $75 to $150, and the per diem rates from $3 to $10.

Under a cooperative agreement with the Bureau of Soils of the United States Department of Agriculture and the New Jersey State Agricultural Experiment Station, the Survey for two months pays the salary and the field expenses of two field assistants in an agricultural survey. The salary of these field assistants, who are students of the State Agricultural School, is $25 a month.

Under a cooperative agreement with the State road commissioner, two assistants in the chemical laboratory, engaged partly in survey work and partly in work for the State road commissioner, are carried on the commissioner's pay roll at the rate of $50 and $60 a month.

Under civil-service rulings some scientific positions are in the competitive class and others are exempted.

The topographic and engineering work of the Survey is in charge of a consulting engineer of high standing, who has an office in New York City. His employees are detailed to the work as the exigencies of the case demand and are not subject to civil-service regulations. All men in this group are paid on a per diem basis, for time actually employed, at rates ranging from $4 to $10 a day.

APPROPRIATIONS.

Appropriations for the Survey are made annually in the general appropriation bill. They are not contingent on cooperation with any other organization. Unexpended balances in the hands of the State treasurer at the close of the fiscal year (October 31) immediately lapse to the State treasury, although there may be outstanding bills awaiting payment. Under certain restrictions, however, uncompleted contracts may be filed against a balance, and so carry it over into the next fiscal year.

The present annual appropriation is $16,500. With the exception of the salary of the State geologist, the payment of which is specified in the bill, the expenditure of the appropriation is left to the State geologist. Special funds have sometimes been provided for specific investigations ordered by the legislature.

The expenditures for 1909 may be classed as follows:

	Per cent.
Administrative and routine clerical work	28
Topographic work (field work, office work, and publication)	9
Economic, stratigraphic, and areal geology	36
Statistical geology	4
Paleontologic geology	1
Chemical work	11
Underground water resources	3
Stream flow and reservoir sites	3
Testing road materials, etc	3

PUBLICATIONS.

From 1864 to 1909, inclusive, the Survey has issued an annual report for each year except 1868. These include administrative reports and scientific papers. In 1868, at the completion of the first four-year period of the Survey, a final report, entitled "Geology of New Jersey," by G. H. Cook, was published. This series of annual reports, with accompanying scientific papers, is to be replaced by a series of bulletins, numbered consecutively and each dealing with a distinct subject. The annual administrative report of the State geologist, dealing with the business of the Survey, will hereafter be issued as one of this series of bulletins.

In 1888 a series of monographs, or so-called final reports, was commenced. These are published at irregular intervals. Volumes 1, 2 (pts. 1 and 2), 3, 4, 5, 6, and 7 of this series have already appeared.

In 1886 a series of reports on paleontology was commenced. Volumes 1 and 2 were published in cooperation with the United States Geological Survey, and appeared also as monographs. Volume 3 was issued in 1903 and volume 4 in 1907.

Two series of topographic maps are published and kept in stock. One series is on a scale of 1 mile to the inch and covers the entire State. This series was surveyed originally from 1880 to 1887, in cooperation with the United States Geological Survey, but by a topographic corps organized by the State Survey. The entire cost of this work, exclusive of the primary triangulation by the United States Coast and Geodetic Survey, but including tertiary triangulation over about 2,000 square miles, was $54,744.58, or $6.93 per square mile. Work done by earlier organizations reduced the cost about 50 cents per square mile, and if the Survey had been compelled to furnish its own triangulation the cost would have been about $10 per square mile. About half of the expense of this work was met by the United States Geological Survey. These maps have been revised from time to time and the culture brought down to date. Twenty sheets make up this set. The second series of topographic maps is on a scale of 2,000 feet to the inch and covers the metropolitan district. The topography is taken from the earlier maps, revised where necessary, and additional data relating to culture added. Twenty-four sheets of this series have been published and are kept in stock.

Geologic folios, data for which are furnished in part by the members of the State Survey, are published in cooperation with the United States Geological Survey, a special edition of 1,000 copies being prepared as the "Geologic Atlas of New Jersey."

Of the annual reports, 4,500 copies are published and about 3,700 distributed immediately. Editions of the final reports vary from 2,000 to 5,000 and of the paleontologic reports from 1,000 to 1,500. Maps are printed in editions of 1,000. The reports are distributed without charge, excepting the last 200 copies of each edition, which are sold at cost. For the larger reports recipients are required to pay postage or express charges. Maps are sold at 25 cents a sheet, and geologic folios at the same price as fixed by the United States Geological Survey. The average annual income from the sale of publications is from $1,100 to $1,200, which is paid monthly to the State treasurer and can not be redrawn for the use of the Survey.

The average annual cost of printing the Survey reports and accompanying maps from 1902 to 1909, inclusive, the period of the present

administration, has been $3,200, or $2,131 for each report. The cost of the annual reports has ranged from $554 to $2,204, and for volumes of the final report and paleontologic series from $912 to $7,000. The average cost of reports from 1891 to 1900 was $5,484. The cost of printing reports and maps which accompany them is paid from the appropriation for public printing. The cost of engraving and printing the topographic atlas sheets and the cost of the geologic folios is paid from the appropriation for the support of the Survey.

All matters relating to the printing of maps paid for from Survey funds are solely in the hands of the State geologist. Contracts for printing reports are awarded by the State printing board (composed of the governor, State comptroller, and State treasurer) after competitive bidding. The quality of paper and size of type are fixed by them, according to certain legal requirements. The subject matter of the reports, the style, the number of illustrations, etc., have for two or three years been subject to the censorship of the editor of public documents. This censorship is by no means formal, and some departmental reports are vigorously pruned. Reports of the Survey, however, have heretofore been passed without change. Special reports (not annual reports) must be ordered printed by the State printing board.

About 100 copies of each report are retained by the superintendent of public documents for use of the legislature. The remainder of the edition is delivered to the Survey for distribution. Reports are sent to working geologists, to other geological surveys in this country and abroad, to public libraries in New Jersey, to many colleges, universities, and libraries in other States, and to citizens of New Jersey and other States who request them. The mailing list is kept alive chiefly by the elimination of those who for two or three years in succession neglect to return the acknowledgment card inclosed in each report, and by the addition of those requesting that reports be sent to them regularly.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

The present main lines of work of the Survey, independent of other departments or bureaus, are as follows:

1. Revision and publication of new editions of topographic maps as rapidly as old editions are exhausted. On an average two or three new atlas sheets are published annually. On some sheets the changes in the culture have been so extensive as to necessitate the engraving of new copper plates to replace the lithograph stones.

2. The compilation and publication of a new State geologic map in two sheets on a scale of 1:250,000.

3. The publication of a report on iron ores and iron mining and the preparation of a report upon the surface formations of the Coastal Plain, the field work of which has already been completed.

4. Paleobotanic investigations of the flora of the Coastal Plain deposits.

5. The testing of coal purchased by State institutions to determine its heat-producing values.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—Cooperation with the Federal Survey is being carried on along several lines:

1. Geologic folios, to which workers of both surveys have contributed, are engraved and printed by the United States Geological Survey. At the time of printing a certain number are struck off for the State Survey. These are bound in a special cover and sold to the State Survey at cost of presswork and paper. Four of these joint folios have already been published and others are in preparation.

2. In 1909 the State Survey cooperated with the United States Geological Survey in the collection of statistics of mineral production in the State. This plan of cooperation was not carried out during 1910, owing to the taking of the national census, but it is expected that it will be resumed in 1911.

3. The State geologist has been appointed a special agent of the United States Geological Survey for the collection of well data and as such finds the work of obtaining well records and samples greatly facilitated. The records are filed with the State Survey and are open to inspection at any time by members of the National Survey.

Other State surveys.—No cooperative work is carried on at the present time with geological surveys of other States.

United States Bureau of Soils.—In 1909 the Bureau of Soils of the United States Department of Agriculture, the State Agricultural Experiment Station of New Jersey, and the Geological Survey of New Jersey entered into a cooperative agreement relating to an agricultural and soil survey of the State. Most of the work in connection with the chemical analyses of the soils is done by the State Survey, which also contributes to the expenses of the field parties in both the soil survey and the agricultural canvass, the other two bureaus bearing the remainder of the field expenses and making the necessary physical determinations.

State road commissioner.—The State Survey is cooperating with the State road commissioner in the construction of improved State roads, of which New Jersey now has 1,527 miles. The Survey from time to time furnishes the commissioner with information regarding

the occurrence of materials suitable for roads and passes on the suitability of materials submitted by road contractors. A more important line of work during the last two years has been in connection with the use of asphaltum binder and heavy residual oils in the construction of macadam roads. A large part of the time of the chemist of the Survey has been devoted to investigations to determine the best type of oil to be used and to framing specifications. During the road-building season, before the oil is used, samples from each carload supplied are required to be tested in the laboratory of the Survey, to determine whether or not the oil conforms to the specifications. The expense of this work is defrayed in part by the State road commissioner.

NEW YORK.

PREVIOUS SURVEYS.

The Geological Survey of New York is the outgrowth of the scientific activity of Amos Eaton, first senior professor of the Rensselaer School, at Troy, supported by the substantial patronage of Gen. Stephen Van Rensselaer and the encouragement of Gov. Dewitt Clinton. At the request of the latter, Eaton delivered lectures on geology and allied sciences before the legislature of the State, and under the patronage of Van Rensselaer he executed geologic surveys of Rensselaer County and the district adjoining the Erie Canal. After several recommendations by Gov. Clinton, and in response to later petitions from organized societies in Albany and New York, the secretary of state, John A. Dix, was in 1835 authorized to present to the legislature a plan for a general natural-history survey of the State, in which scheme a geologic survey was to hold a leading place. This report, rendered in 1836, formed the fundamental plan on which the Geological Survey of New York was based. In accordance therewith the State was divided into four districts, with a district geologist and one assistant in charge of each, and it was believed that four years would be sufficient for the accomplishment of the work. Annual reports were to be rendered by each chief geologist, and final reports were to be submitted at the close of the work.

The district geologists appointed under the provisions of this act were Lieut. W. W. Mather, Prof. Ebenezer Emmons, Lardner Vanuxem, and Timothy A. Conrad. In 1837 a partial rearrangement of these appointments was made, by which James Hall, assistant during the first year to Prof. Emmons, took the place of Mr. Conrad, the latter being appointed paleontologist to the Survey. Concomitant with this change was a redivision of the western or third and fourth districts by a north-south line instead of an east-west line. It was not till 1842 and 1843 that the final reports were sub-

mitted, and with their submission the organization terminated its active existence as such, though the title of the Survey has never been abrogated. The publications of this early Survey comprised 16 annual reports and four final reports.

The work of the organization was continued by the designation of Prof. Emmons to take charge of the reports on agriculture (in which this distinguished geologist found opportunity to expound in full his Taconic system of rocks), and by the appointment of James Hall to continue the work on the paleontology of the New York formations. The title of State geologist and paleontologist was thus kept alive by the activities of Prof. Hall, and in 1892 both were reaffirmed by a new commission issued to Prof. Hall by Gov. Flower. The 13 quarto volumes devoted to the paleontology of New York, which were published between the years 1842 and 1894, constitute a monument to the labors of James Hall and his assistants and form one of the standards of North American paleontology.

In 1898, on the death of Prof. Hall, the regents of the University of New York, who had statutory control of the offices, appointed F. J. H. Merrill as State geologist and John M. Clarke as State paleontologist.

In 1904, on the consolidation of the University of the State of New York and the Department of Public Instruction into the Education Department, John M. Clarke was appointed State geologist and paleontologist, and he still holds these titles, in connection with the directorship of the Science Division of the Education Department and the State Museum.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is known as the Science Division (Geological Survey) of the Education Department; it was organized in 1904.

SUMMARY OF LAWS.

Under the codified education law (1910), the commissioner of education and the regents of the University of New York appoint the State geologist and paleontologist. No other statute bears on this office. The work of the official and of the division is a matter of agreement between the appointee and the commissioner.

ORGANIZATION.

The governing authority is vested in the commissioner of education and the regents of the University of the State of New York. The commissioner is appointed for life by vote of the regents. The

regents are elected to office, for specific periods, on joint ballot of the State senate and assembly.

The executive officer is the State geologist and paleontologist, who is appointed by the commissioner of education and the regents of the University of New York. His term of office is during efficiency and good behavior. The State geologist is also director of the Science Division of the Education Department. The present incumbent is John M. Clarke. The State geologist and paleontologist receives an annual salary, fixed annually by law, on recommendation of the commissioner of education.

The permanent force of the Survey consists of six clerical assistants and seven geologic assistants. In addition, from five to twelve temporary geologic assistants are employed as required by the work of the Survey. The temporary assistants are college professors and, occasionally, advanced students. All appointments are made on recommendation of the State geologist, with the approval of the commissioner of education. All permanent positions are subject to competitive civil-service examination. Temporary appointments are subject to exemption by the State civil-service commission.

APPROPRIATIONS.

Appropriations are annual. None are contingent on cooperation. Unexpended balances are carried over, except in case of salaries, which lapse at the close of the fiscal year.

The salaries of the permanent staff amount to $21,260. Expenses, including cost of temporary assistants, are estimated at $7,000. The appropriation for maintenance covers the entire Science Division.

PUBLICATIONS.

The publications of the Survey consist of a series of bulletins and a series of memoirs. Annual reports are issued as bulletins. All are included in the annual reports of the State Museum and are also published separately. The editions vary from 3,000 to 5,000.

The publications are distributed gratuitously to registered libraries and scientific correspondents; the remainder are sold. The income from the sale of publications is deposited daily with the State treasurer.

The average annual cost of printing is $25,000. This is paid from the State printing fund. The printing is done by the State printer, under general contract with the State. The sizes of the reports are standard—quarto for memoirs and octavo for bulletins. The paper, illustrations, and contents are left to the State geologist and paleontologist, subject to approval of the commissioner of education.

Aside from the stipulation that copies of all publications shall be sent to registered libraries, the distribution is left to the State geologist.

PRESENT LINES OF WORK.

The present lines of work of the Survey comprise economic and tectonic geology, stratigraphy, areal mapping, surficial geology and mapping, mineralogy, and paleontology.

No cooperation is maintained.

NORTH CAROLINA.

PREVIOUS SURVEYS.

In 1823 an act of the general assembly of the State of North Carolina authorized the board of agriculture to pay the expenses of "geological excursions" for a period of years. The work was begun by Prof. Denison Olmsted, of the State University, and during his incumbency nine reports were published.

Upon Prof. Olmsted's removal to Yale in 1825 the Survey was continued by Dr. Elisha Mitchell, also of the State University, under whose direction nine reports were published.

In 1852 Dr. Ebenezer Emmons was appointed State geologist, and during his service 23 reports on the geology and natural history of the State were published.

On the death of Dr. Emmons, in 1866, Dr. W. C. Kerr was appointed State geologist, and carried on the work until his death in 1885. During Dr. Kerr's administration 21 reports and scientific papers were published.

After the death of Prof. Kerr the Geological Survey was allowed to lapse until 1891, when the North Carolina Geological Survey was established, and Prof. Joseph A. Holmes, of the State University, was appointed State geologist. The object of this Survey, as expressed in the act of the general assembly authorizing it, was "the thorough examination of the nature and extent of the mineral and timber resources of the State." The Survey continued its work for 14 years and during this time issued 12 bulletins, 8 economic papers, biennial reports Nos. 1 to 7, covering the period 1891 to 1904, and a series of good roads circulars numbered from 1 to 37.

The act creating the North Carolina Geological Survey was repealed by the legislature in 1905 and a new act was passed establishing the present Survey.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is known as the North Carolina Geological and Economic Survey; it was established by the General Assembly of North Carolina in February, 1905.

During 1905 and until October, 1906, Joseph Hyde Pratt, State mineralogist, was acting State geologist, in the absence of Prof. Holmes, who was in St. Louis as chief of the department of mines and metallurgy of the Louisiana Purchase Exposition. On October 29, 1906, Dr. Pratt was formally appointed State geologist.

SUMMARY OF LAWS.

The act establishing the North Carolina Geological and Economic Survey provides that the State geologist shall be appointed by the governor to conduct the work of the Survey under the supervision of a board of managers, known as the geological board. The board is to consist of the governor, as chairman, and four citizens of the State, who are appointed by the governor, with the approval of the senate, two for a period of two years and two for a period of four years, beginning March 1, 1905. The objects of the Survey, as defined in this act, are as follows:

1. An examination of the mineral, forest, fishery, and other material resources of the State.
2. An examination of the geological formations of the State with reference to their economic products.
3. An examination of the road-building materials and the best methods of utilizing the same.
4. An examination and classification of the soils and forests and other physical features of the State with special reference to their bearing upon the occupation of the people.
5. An examination of the streams and water powers of the State with special reference to the development for manufacturing enterprises and the preservation of the sources of these streams through the protection of the forests.
6. The consideration of such other scientific and economic problems as in the judgment of the geological board shall be deemed of value to the people of the State.
7. The preparation of such reports, illustrations, and maps as may be deemed necessary in placing the results of these investigations before the public.
8. And the State geologist, with the approval of the geological board, is hereby authorized to arrange for and accept such aid and cooperation from the several United States Government bureaus and other sources as may assist in completing the topographic surveys of the State and in carrying out other provisions of this act.
9. An examination of the water supplies of the State with special reference to the sinking of deep or artesian wells.

ORGANIZATION.

Governing board.—The governing body is the geological board, appointed as stated above. The members of the board are reimbursed the amount of their actual traveling expenses, and "members not otherwise receiving a salary from the State may, in addition, be paid a per diem of $4 for not exceeding eight days during any one year."

Executive officer.—The executive officer is the State geologist. The present incumbent is Dr. Joseph Hyde Pratt, who was appointed by the governor October 29, 1906, for a term ending January 1, 1909, or until his successor is appointed. Dr. Pratt is also professor of economic geology in the University of North Carolina, but spends practically all of his time on Survey work. He receives an annual salary, the amount of which is fixed by the geological board, and which is paid in monthly installments.

Subordinates are chosen by the State geologist, with the approval of the geological board.

Clerical force.—The office assistants include a secretary, a stenographer, and two clerical assistants, one of whom also serves as janitor.

Geologic division.—There is no regular geologic assistant at present, but geologists are employed temporarily for specific work. Cooperation with the United States Geological Survey exists, and the geologists employed by the State Survey have included Federal geologists as well as professors from the University of North Carolina and from other colleges and a few advanced college students.

Topographic division.—Under cooperative agreements the North Carolina Geological and Economic Survey has employed United States Geological Survey men for all topographic work done in North Carolina. The salaries of these men are fixed by the Federal Survey. The State Survey's allotment for this work has been from $1,000 to $2,500 a year. A part of this fund is furnished by the counties in which special mapping is being done.

Highway division.—The Survey regularly employs a highway engineer at a fixed salary, and from time to time other engineers are employed for limited periods. W. L. Spoon is in charge of this work. During the summer months of 1910 from 10 to 12 college students were employed on surveying parties in the location and construction of roads. Much of this work is done under cooperation with counties and individuals.

Forestry division.—The work of the forestry division of the Survey is under the direction of the forester, J. S. Holmes. He is assisted, however, by men from the United States Forest Service, who are placed in the State on a cooperative basis.

Drainage division.—Through the efforts of the North Carolina Geological and Economic Survey a bill has been passed looking to

the drainage of swamp and overflowed lands in the State. These lands have been divided into districts, and all persons owning lands in these districts bear their part of the expense of the drainage work in proportion to the benefits derived. The Survey has charge of the drainage of certain of the State lands belonging to the State board of education, to the extent of approving the accounts of the drainage engineers engaged in the work.

Natural history division.—Through the efforts of the Survey the legislature of 1907 passed a bill establishing the North Carolina Fish Commission. This commission is under the direction of the Geological Survey, its accounts being subject to approval by the State geologist. The influence of the commission is limited, however, owing to the fact that under the law certain areas are not under its jurisdiction, and efforts are being made to procure remedial legislation. The object of the commission is the preservation and scientific study of the principal fishes of economic value and the encouragement of the cultivation of the oyster and the diamond-back terrapin.

The North Carolina Geological and Economic Survey, in cooperation with the State Audubon Society, has in preparation a report giving a list and description of the birds found in North Carolina.

It is the purpose of the Survey to issue as complete a report as possible on the flora of the State.

APPROPRIATIONS.

Appropriations are annual and are not contingent on cooperation. Balances are carried from one fiscal year to another. The amount of the appropriation is $15,000 annually, $5,000 of which is to be devoted to road work and the remainder expended for such purposes as shall be approved by the geological board. The expenditures for the fiscal year 1908–9 were in about the following proportions:

	Per cent.
Administration	36
Topography	10
Economic, stratigraphic, areal, chemical, and statistical geology	10
Paleontology and underground water resources	6
Drainage supervision (cost of construction is paid by owners of lands to be drained)	2
Stream flow and reservoir surveys	2
Highway engineer	19
Forestry	15

PUBLICATIONS.

The publications of the North Carolina Geological and Economic Survey consist of a series of bulletins, of which 10 have been issued; a series of economic papers, of which 11 have been issued; three

special volumes; two biennial reports; a series of press bulletins, numbered from 1 to 39; and a series of good-roads circulars, numbered from 38 to 57. These treat of a wide range of subjects, including geology, forestry, biology, water powers, mining, etc., but are chiefly of an economic nature.

The edition of all except the press bulletins and the good-roads circulars is 3,000 copies.

The publications are distributed free of cost, except postage.

The cost of printing reports and maps is paid out of the State treasury. The cost of preparing maps is paid out of the Survey fund, the expense of preparing the county maps being shared by the counties.

The reports are printed by the State printers. The Survey has choice as to style of reports, kind of paper, illustrations, etc.

The Survey has entire control over the distribution of the reports. The exchange list consists of all reciprocating geological surveys, all Government departments desiring the reports and furnishing franks for mailing, and institutions and persons who furnish their publications as exchanges. This list is kept alive by correspondence, by use of the monthly list of the Library of Congress, and by a mail-card list, the persons and institutions on which are notified of each new publication and of the amount of postage it requires.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

Most of the work now being prosecuted by the North Carolina Geological and Economic Survey is broadened and made more effective by cooperation with some Federal department, county, or individual. The principal independent report at present in preparation is a volume on the mineral resources of North Carolina.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—Several investigations are in progress in cooperation with the Federal Survey. Reports on the geology and water resources of the coastal plain of North Carolina have been prepared and are going through the press. Under this agreement the North Carolina Survey paid the salary and expenses of three of the investigators, also a stipulated sum to Dr. William Bullock Clark, of Johns Hopkins University, who has had general supervision of the work.

A cooperative investigation of the mica deposits of the State is also in progress.

Statistics of the production of minerals in North Carolina are collected in cooperation with the United States Geological Survey.

In topographic and traverse mapping the North Carolina Geological and Economic Survey has undertaken to complete maps of certain counties in the State. The county pays half of the cost of the field work, the State Survey the other half, and the United States Geological Survey prepares the map for the engraver.

Other departments of the National Government.—In the highway work the State Survey has the cooperation of the United States Office of Public Roads, which furnishes lecturers on the subject and frequently an engineer to construct sample roads in different townships and counties. No special appropriation for this work is made from either bureau. The State Survey has also cooperated with the North Carolina Good Roads Association and the Southern Appalachian Good Roads Association in issuing good roads literature and press bulletins, which have had a decided educational value.

The forestry division of the State Survey has had the active cooperation of the United States Forest Service. The State Survey pays the salary and expenses of a State forester, and the United States Forest Service pays the salary and expenses of a Federal forester.

The Fish Commission of North Carolina is under the supervision of the State Geological Survey, and this commission has been assisted by the United States Coast and Geodetic Survey and the United States Bureau of Fisheries in the work of laying off the restricted territory for fishing.

Other scientific bureaus of the State.—In the drainage work the State Geological Survey has cooperated to a certain extent with the State Board of Education in the drainage of certain State lands.

NORTH DAKOTA.

PRESENT SURVEY.

The present organization is the first Geological Survey of North Dakota.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is known as the North Dakota Geological Survey. It was established by act of the legislature in 1895.

SUMMARY OF LAWS.

The following is a summary of the laws governing the Survey:

The board of trustees of the State University is authorized to carry on a geologic survey of the State. The objects of the Survey are to investigate the geologic formations, together with their ores, coals, clays, mineral waters, marls, cements, building stones, and other useful materials; to collect and tabulate such meteorologic statistics

as may be needed to determine the climate of various parts of the State; to ascertain, by barometrical observations or otherwise, the elevations of different parts of the State; and to prepare a geologic map of North Dakota, upon which the geologic formations shall be represented by means of colors and patterns.

The Survey is authorized to collect specimens of all rocks, soils, ores, coals, fossils, cements, building stones, etc., and to preserve them for public inspection in the University of North Dakota. So far as practicable, duplicate specimens shall be collected for purposes of exchange with other universities and scientific institutions, of which the Smithsonian Institution shall have the preference.

On the completion of any piece of work the Survey is to prepare a report embodying all useful and important information accumulated in the course of the investigation.

The professor of geology in the State University is designated ex officio State geologist.

ORGANIZATION.

The governing board of the North Dakota Geological Survey is the board of trustees of the State University, which is composed of five members, appointed by the governor for a term of four years. The members serve without compensation, but are reimbursed for traveling expenses incurred while attending the meetings of the board.

The present State geologist is Prof. Arthur Gray Leonard, who was appointed to the professorship of geology in the State University in July, 1903. The appointment is without fixed time limit. Approximately half the time of the State geologist is given to the work of the Survey. He receives an annual salary as professor in the university, and in addition is paid a per diem rate while engaged in field work for the Survey. The salary is fixed by the governing board. The assistant professor of geology in the State University is assistant geologist on the Survey, being appointed by the board for an indefinite term. During the field season several advanced students are employed by the State geologist in the work of the Survey, their salaries ranging from $40 to $60 a month.

APPROPRIATIONS.

The appropriation for the Survey is a continuing one and is not contingent on cooperation. Unexpended balances are carried over to the next fiscal year. The annual appropriation is $1,000. Approximately 90 per cent of this is devoted to economic, stratigraphic, and areal geology and about 10 per cent to administrative and clerical work.

PUBLICATIONS.

The publications of the Survey consist of biennial reports, five of which have been issued. The size of the edition is 3,000. The reports are distributed free, except postage.

The average cost of the reports is about $1,000 a year. The cost of the printing does not come from the Survey appropriation but from other State funds. The Survey has no choice as to the printer, the statutes providing that the State printer shall do the work. The selection of the paper rests largely with the printer, but otherwise the Survey has full control over the printing, including the contents of the reports, where and by whom the maps and illustrations shall be made, and the style of the reports.

The Survey has full control over the distribution of its reports. The mailing list includes the public and school libraries of North Dakota, the State officers and members of the legislature, many of the State newspapers, and persons who have asked to be placed on the list. It also includes many public libraries throughout the United States, the libraries of many colleges and universities, scientific and other learned societies at home and abroad, libraries of other geological surveys, and a large number of geologists and others interested in the reports. As the reports are issued notices of their publication are sent out, and all who respond by sending the necessary postage receive copies.

PRESENT LINES OF WORK.

Independent investigations.—The main lines of work which are being carried on by the Survey at the present time are as follows: (1) A study of the late Cretaceous and early Tertiary formations of western North Dakota, including the mapping of these formations; (2) the continued investigation of the lignite deposits of the State; (3) the study of the Devils Lake area, with particular reference to its physiographic features; and (4) the detailed study of the geology and economic resources of other selected areas.

Cooperation with United States Geological Survey.—In cooperation with the United States Geological Survey data regarding the underground waters of North Dakota are being collected as rapidly as possible.

OHIO.

PREVIOUS SURVEYS.

FIRST GEOLOGICAL SURVEY.

On December 8, 1835, Gov. Robert Lucas, in his annual message to the general assembly of Ohio, recommended the establishment of a Geological Survey. This was the first official indorsement of

such an enterprise in Ohio. The assembly responded with a joint resolution appointing a committee of four, headed by Dr. S. P. Hildreth, one of the best-informed men in Ohio on the geology and natural resources of the State, who were to report to the next assembly the best method of securing the desired end.

The committee submitted a carefully prepared report, and in March, 1837, an act was passed providing for "a complete and detailed geological survey of the State." The work planned was comprehensive, including not only matters strictly geologic, but also analyses of soils, ores, marls, and waters. The preparation of a geologic map of the State was specifically mentioned, as was a collection of the rocks, ores, and fossils. It was proposed to send sets of these to the principal educational institutions of the State, thus bringing the Survey closely into touch with the scholars of Ohio.

The committee thought that the work of such a Survey might be completed in four years, with an annual appropriation of $12,000. This part of the report appears humorous, in view of the area of the State, the large amount of work done by the second and subsequent surveys, and the fact that "a complete and detailed survey" is still in the distant future. Doubtless, however, present ideas of a "detailed survey" are quite different from those of 1837.

The law empowered the governor to employ a "competent and skilled geologist." Even in those days appointments were apparently sometimes made on a basis other than merit, and the legislature concluded to take no chances in regard to the new scientific bureau. The law made provision for geologic assistants, not to exceed four in number, and for a topographical engineer, who should, among other things, "ascertain by accurate barometrical observations the height of the principal mountains of the State."

The governor appointed W. W. Mather, of New York, principal geologist, and S. P. Hildreth, John Locke, J. P. Kirtland, and C. Briggs, jr., assistants. Charles Whittlesley was chosen topographic engineer. The selections were of the best, and the Survey started with the good will and rather high expectations of the people.

Field work began in 1837, and in December the first annual report was filed with the governor. This was published in 1838, under the title "First Annual Report of the Geological Survey of the State of Ohio," by W. W. Mather, principal geologist, and the several assistants. This modest volume of 134 pages discussed various subjects, such as coals, iron ores, and salt.

Field work was continued during the summer of 1838, and a report on this work was filed with the governor the following December. It contained a description of the general geology of the State and a discussion of special topics, such as dip, topography, and coal. The publication of this second annual report marked the close of the

first Survey. The causes for its abrupt termination are not well known, but perhaps the financial crisis was the leading factor. According to Dr. Orton the principal facts established by this Survey were as follows: (1) The oldest rocks of the State are the so-called blue limestone formation of southwestern Ohio; (2) the newest bedded rocks are the "Coal Measures" of southeastern Ohio; and (3) a very gentle southeasterly or southerly dip prevails throughout Ohio, a proper understanding of which renders its stratigraphy intelligible.

SECOND GEOLOGICAL SURVEY.

Efforts to renew the Survey were made in succeeding years, but without success until 1869. At that time Gov. Hayes took the lead and the Geological Survey of Ohio was reestablished without difficulty. The work was to be completed in three years. The governor appointed J. S. Newberry chief geologist; E. B. Andrews, Edward Orton, and J. H. Klippart assistant geologists; and T. G. Wormley chemist. Klippart was interested in agriculture and was expected to give his attention to that important field. Local and special assistants were from time to time appointed, some of whom were or have since become leaders in their respective fields. The list includes G. K. Gilbert, R. D. Irving, J. J. Stevenson, N. H. Winchell, F. B. Meek, E. D. Cope, James Hall, O. C. Marsh, R. P. Whitfield, and D. S. Jordan.

Newberry outlined a comprehensive plan for the Survey, including a thorough discussion of the stratigraphy and paleontology of the entire State. The economic side was to be considered in one volume, and agriculture, botany, and zoology were to be treated in another volume. At the close of the three years a large part of this work remained to be done.

Reports of progress for 1869, 1870, and 1871 were published. That for 1869 contained a geologic map of Ohio, being the first official publication of the kind to be issued by the State. A series of detailed reports followed. Of these, volume 1 was published in 1873, volume 2 in 1874, and volume 3 in 1878. These reports are devoted principally to a review of the geology of the State, by counties, but part 2 of volume 1 and part 2 of volume 2 relate to paleontology and contain numerous fine lithographic plates of which students of paleontology are justly proud. The expense of these plates, however, was large, those of volume 1 alone costing $34,000. Volume 4 was published in 1882. Instead of treating of agriculture, botany, and zoology, as was expected, it is devoted entirely to vertebrate zoology.

These volumes were issued in editions of 20,000, and the expense to the State was heavy. In 1879 a geologic map of the State on a

scale of 4 miles to the inch was issued. This is the basis of the maps of 1888 and 1909.

Early in the history of the Survey criticism arose. The people expected that the publications would treat prominently of the economic resources of the State, and had little interest in the elaborate plates given to fossil plants and animals. In April, 1872, the law was changed and provision was made for a geological board, consisting of the governor, school commissioner, and treasurer, who should have general supervision of the survey. Unfortunately the chief geologist lived in New York and was absent from Ohio during a large part of the year, especially in winter, when the general assembly was in session. A financial crisis increased the difficulty. Appropriations were made with growing opposition and were finally discontinued.

The live interest in the economic resources of the State, however, is shown by an appropriation passed April 17, 1882, to cover the cost of preparing the long-delayed economic volume. But this act also stipulated that "upon the publication of said volume 5 the Geological Survey of Ohio is hereby declared to be completed." The work was to be in charge of a geologist appointed by the governor, who at once (April 17) appointed Edward Orton. In 1884 volume 5 appeared. It is devoted almost wholly to coal, and is the most sought publication of the Survey.

Notwithstanding its action in 1882, limiting the life of the Survey, the general assembly on May 1, 1885, made provision "to extend and complete the account of the economic geology of the State that was begun in volume 5." In 1886 Dr. Orton published a preliminary report (76 pages) on petroleum and natural gas, and in 1888 the detailed report (vol. 6) on those products appeared. This volume has proved almost as popular as volume 5. It seems safe to state that these two volumes have done as much to render the Survey popular with the people of Ohio as all other publications of the organization combined.

Though large editions of the early reports (vols. 1 to 6) were issued, they were distributed almost wholly pro rata among members of the general assembly. As a result the members found themselves in possession of hundreds of volumes for which there was no demand, and many of these were destroyed. No thought was taken of the future, and in a few years persons desiring volumes were compelled to search the shelves of secondhand-book stores.

THIRD GEOLOGICAL SURVEY.

In 1889, on the recommendation of Dr. Orton, the legislature provided for the third organization of the Geological Survey of Ohio. A small yearly appropriation was made, enabling the State geologist,

Dr. Orton, to keep in touch with work in progress and to present the results in annual reports. The scope of the Survey was made very broad, and while permission was given to collect and describe the fossils of the geologic formations, the law forbade any expenditure for this purpose that was not expressly provided for by the legislature. Probably this was attributable to the heavy expenditures made for part 2 of volumes 1 and 2. The first annual report of this Survey appeared in 1890. In the fall of 1891 Dr. Orton's health failed, incapacitating him from active field work, but publications on the results accomplished by the Survey were continued under his direction, part 1 of volume 7 appearing in 1893 and the complete volume (parts 1 and 2) in 1894.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is known as the Geological Survey of Ohio; it was organized under the laws of 1889 and 1902.

HISTORICAL SKETCH.

In the autumn of 1899 Edward Orton, jr., was appointed to the vacancy created by the death of his father, and in 1902 he completed the fourth organization of the Geological Survey of Ohio. The laws of the third organization were not repealed, but important additions were made, relating to the publication and distribution of the reports. Provision was made for issuing a series of bulletins, which were later to be assembled and bound into volumes, thus maintaining the series started by Newberry and continued by Orton. This was regarded as a more expeditious and economical method of making public the results accomplished. Without difficulty Prof. Orton secured an appropriation, and in the summer of 1900 field work was once more begun. Prof. Orton gave the work of the Survey a more practical trend than it had previously had, as is well shown by the titles of the bulletins—for example, "Uses of Portland cement," "Manufacture of Portland cement," and "Sand-lime brick." Finding that he could not devote to the Survey the time that he deemed necessary, Prof. Orton retired in 1906, and J. A. Bownocker, the present incumbent, was appointed to succeed him.

Since Mr. Bownocker's appointment only one addition has been made to the laws relating to the Survey, and that empowers the State geologist to purchase and keep on sale publications of the Survey now out of print. In 1910 a general code of the laws of Ohio was adopted, and the laws governing the Survey were all assembled.

SUMMARY OF LAWS.

1. The governor may appoint a State geologist, who shall serve for a term of three years, unless removed for cause. He may employ such assistants as he deems necessary.

2. The State geologist shall receive for his services $200 for each month for the time employed in the discharge of his official duties. Each assistant shall receive such compensation as the State geologist may allow. The necessary traveling and incidental expenses of the geologist and assistants shall be paid each month from the State treasury on presentation of an itemized voucher approved by the governor.

3. The State geologist shall investigate the geologic structure and resources of the State. He shall determine as nearly as possible the number and extent of geologic formations, and from time to time represent them on maps and diagrams. He shall study the occurrence and distribution of useful minerals and products of such formations, determine their chemical composition and structure, investigate the soils and water supply of the State, and give attention to the discoveries of coal, building stone, natural cement, petroleum, gas, and other natural substances of use and value. He may also collect and describe the fossils of geologic formations of the State, but no expenditure shall be incurred therein unless authorized by the general assembly.

4. When a bulletin has been completed, the commissioners of public printing shall determine the number of copies to be printed and the grade of paper and kind of binding to be used and shall provide for a proper publication. Each issue of a bulletin shall consist of not less than 3,000 copies. One thousand copies shall be distributed pro rata among members of the general assembly, and each member may draw 50 additional copies. One thousand copies shall be distributed by the State geologist in exchange with other surveys and among persons whose services have been employed in the collection and preparation of matter used therein. Not more than 400 copies of a bulletin may be distributed in this manner during the first year after its publication, and not more than 50 copies in any subsequent year. One thousand copies shall be reserved for binding. When a sufficient number of other bulletins have accumulated to make collectively a volume of not less than 800 pages, they shall be bound in such a way as to correspond with the preceding volumes of the Survey.

5. The State geologist shall distribute the bound volumes of the Survey as follows: (1) To the State library, 100 copies; (2) to each member of the general assembly, 1 copy and, on application,

not to exceed 2 additional copies; (3) to each public library of the State, 1 copy; (4) the remaining copies may be distributed in exchange with other geological surveys and societies of the United States and foreign countries.

6. The expenses of printing, illustration, stereotyping, and binding of the bulletins and volumes shall be paid from the appropriation for State printing.

7. The State geologist may purchase, repair, and sell, at such prices as to cover the expenses, publications of the Survey now out of print.

8. The State geologist shall make an annual report to the governor on the work for the preceding year. The report shall state the number of bulletins and geologic reports distributed, the number of each issue sold, the money received and expended, and the number of bulletins and bound volumes on hand.

ORGANIZATION.

The executive officer of the Survey is the State geologist. The present incumbent, J. A. Bownocker, was appointed in December. 1906, to fill the unexpired term of Edward Orton, jr., resigned. He was reappointed April 22, 1907, and again in 1910. His present term expires in 1913. The State geologist holds a professorship in the Ohio State University and gives only about one-third of his time to the Survey during the academic year, and full time during the summer vacation of three months. During the vacation period he receives a salary of $200 a month and traveling expenses, as provided by statute; during the remaining nine months his compensation is $50 a month, the amount appropriated by the general assembly.

The clerical force consists of one stenographic clerk.

The scientific assistants are appointed by the State geologist and include geologists, chemists, and engineers. At present the scientific staff is chosen almost entirely from professors in higher institutions of learning and advanced students who have selected geology for their life work. The field work is performed largely during the summer vacation. During 1910 ten geologists, two chemists, and two engineers were employed. The compensation of assistants ranges from $50 to $100 a month and expenses. It is expected that the maximum figure will be substantially increased for 1911.

The topographic work is not under the direction of the State geologist.

APPROPRIATIONS.

During the last few years appropriations have been made annually, but it is understood that hereafter they will be biennial. Unexpended balances lapse on February 15 following the time the appropriations

become available. Thus far such balances have been reappropriated to the Survey. The appropriation for the year 1910 was as follows: For geologic work, $6,895; for illustrating specimens, $150; total, $7,045. To this should be added unexpended balances and the receipts from the sale of bulletins, the latter aggregating from $200 to $400. The expenditures were divided approximately as follows:

	Per cent.
Administration	22
Economic, stratigraphic, areal, and physiographic geology	36
Applied geology	34
Paleontologic geology	3
Chemistry	5

PUBLICATIONS.

The publications of the present Survey date from 1903 and consist of a series of bulletins, which are from time to time assembled and bound into volumes, thus maintaining the series of volumes started by Newberry. To the present time 11 bulletins have been issued. Bulletins 1 to 3 compose volume 8, Bulletins 4 to 8 compose volume 9, and Bulletins 9 to 11 compose volume 10. These publications are almost wholly of an economic nature.

The editions of bulletins are determined by the commissioners of public printing, but according to law shall consist of not less than 3,000 copies. They are distributed as stated on pages 113–114.

The cost of publishing is paid from the appropriation for State printing, and the Survey lacks data as to the actual figures. State printing is done under a contract, and the Survey has nothing to say as to who shall do the work. The engraver is generally designated by the supervisor of public printing, after competitive bidding. The quality of paper and the kind of binding are determined by the commissioners of public printing. The contents of the bulletins are left entirely to the State geologist.

The State geologist is authorized to purchase, repair, and sell publications of the Survey now out of print at prices which will cover the cost. Receipts from the sales go into the State treasury to the credit of the Survey. For the last three years these receipts were as follows: 1907, $185.72; 1908, $202.94; 1909, $448.15.

PRESENT LINES OF WORK.

Independent investigations.—The Survey is at present engaged in the following investigations:

Economic geology:
- The Bremen oil field.
- Peat deposits of Ohio.
- Building stones of Ohio.

Stratigraphic geology:
- The Mississippian of northeastern Ohio.
- The Mississippian of southern Ohio.

Areal geology:
- The geology of the Columbus area. (For colleges and general readers.)
- The geology of the Cleveland area. (For high schools.)
- The geology of the Delaware area.

Physiographic geology:
- The beaches of glacial Lake Erie.
- The physiography of Ohio.

Applied geology:
- Paving bricks.
- Pottery.
- Sands of Ohio.

In addition to the foregoing, certain stratigraphic lines are being redrawn on topographic maps for use in future editions of the geologic map of Ohio.

Cooperation with United States Geological Survey.—At present the only cooperation with the Federal Survey is in the investigations of peat and of petroleum in southeastern Ohio. The samples are collected by the State Survey and the analyses are made by the Federal Survey.

OKLAHOMA.

PREVIOUS SURVEY.

In 1898 the Legislature of the Territory of Oklahoma established the Geological and Natural History Survey and appropriated for its maintenance $200 a year. This amount was afterwards increased to $300. Under the law the professor of biology at the State University of Oklahoma was ex officio Territorial geologist, the subject of geology, at that time, not being taught at the State University. Prof. A. H. Van Vleet, head of the department of biology, therefore became Territorial geologist in 1898 and served in that capacity until statehood was granted in 1907.

Considering the small amount of money available, the results of Prof. Van Vleet's survey were extremely satisfactory. Assisted by Charles N. Gould, geologist, and Paul J. White, botanist, work in the northern and western parts of Oklahoma was carried on each summer from 1901 to 1906. As a result, two volumes were issued. The manuscript of the first biennial report was burned in a fire which destroyed Science Hall of the State University in 1903. The second biennial report was issued the same year and the third biennial report was issued two years later.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is the Oklahoma Geological Survey; it was organized July 25, 1908.

SUMMARY OF LAWS.

The authority for the establishment of the Oklahoma Geological Survey is contained in section 37 of article 5 of the constitution of Oklahoma, which reads as follows: "The legislature shall provide for the establishment of a State Geological and Economic Survey." The Survey was established by the first Legislature of Oklahoma under the following law:

SECTION 1. There is hereby created a bureau to be known as the Oklahoma Geological Survey, which shall be under the direction of a commission to be known as the State geological commission, composed of the governor, the president of the State University, and the State superintendent of public instruction.

SEC. 2. The said commission shall serve without compensation but shall be reimbursed for actual and necessary expenses incurred in the performance of their official duties. Said commission shall have general charge of the bureau and shall appoint as director of the Survey a geologist of established reputation, who may, with the approval of the commission, appoint such assistants and employees as may be necessary to carry out the provisions of this act. The director, assistants, and employees shall receive such salaries or compensation as may be determined by this commission.

SEC. 3. The said bureau shall have for its object and duties the following:

First, a study of the geological formations of the State, with special reference to its mineral deposits, including oil, coal, gas, asphalt, gypsum, salt, cement, stone, clay, lead, zinc, iron, sand, road-building material, water resources, and all other mineral resources.

Second, the preparation and publication of bulletins and reports accompanied with the necessary illustrations and maps, including both general and detailed descriptions of the geological structure and mineral resources of the State.

Third, the consideration of such other scientific and economic questions as in the judgment of the commission shall be deemed of value to the people.

SEC. 4. The director shall present to the governor a biennial report, ready for printing, showing the progress and conditions of said bureau, together with such other information as the commission may deem necessary: Provided, That the commission shall have authority to print and to distribute said report.

SEC. 5. All materials collected, having served the purpose of the bureau, shall be deposited in the State Museum: Provided, That duplicates may be distributed to the various educational institutions of the State under such regulations as the commission shall formulate.

SEC. 6. In order to carry out the provisions of this act, it shall be lawful for all persons employed by the bureau to enter and cross all lands within the State: *Provided*, That in so doing, no damage is done to private property.

SEC. 7. Until suitable laboratories, libraries, and testing apparatus are provided by the State for prosecuting the work of the Survey, said Survey shall be located at the State University. The commission shall enter into arrangements with the board of regents of the State University for the use, by members of the staff of the Survey, of such rooms, laboratories, libraries, and apparatus as may be necessary for the carrying on of such work.

SEC. 8. The sum of $15,000, or so much thereof as may be necessary, is hereby appropriated out of the funds in the State treasury, not otherwise appropriated, to provide for the payment of actual expenses of the commission,

and for other expenses authorized by them, and for the salaries or other compensation of the director, assistants, or other employees.

SEC. 9. For the preservation of the public peace, health, and safety, an emergency is hereby declared to exist by reason whereof this act shall take effect and be in force from and after its passage and approval.

ORGANIZATION.

Under the law the governing board of the Survey is the State geological commission, which is composed of the governor, who is president of the commission; the State superintendent of public instruction, who is secretary of the commission; and the president of the State University, who is the executive officer of the commission.

The following paragraphs set forth the duties of the officers:

The executive officer is empowered to certify to the State auditor the amount of money required to pay the salaries of the director and other expenses as may be authorized by the commission.

The executive officer is empowered to arrange with the board of regents of the State University for such rooms, laboratories, libraries, and testing apparatus as may be necessary for the work of the Survey, as provided in section 7 of the act establishing the Survey.

The president of the commission is to make known to the Director of the United States Geological Survey, in Washington, and to heads of the geological surveys in the neighboring States the organization of the Oklahoma Geological Survey, and to ask their official aid and cooperation.

The director of the Survey is authorized in the name of the commission to solicit the friendly aid and cooperation of all the citizens of Oklahoma, and particularly all teachers and other professional men of the State.

In conformity with article 3 of section 3 of the act establishing the commission, the executive officer is authorized on the advice of the director to appropriate such funds of the Survey as he may think wise to the investigation of zoological and botanical problems of the State.

The executive officer is authorized to apportion the funds of the Survey, to approve the appointment of assistants and other employees, and to see that the instructions of the commission are faithfully carried out.

The members of the commission, being State officials, do not draw additional salaries.

The active work of the Survey is in charge of the director, who is appointed by the commission. The present incumbent is Charles N. Gould, who was appointed July 25, 1908. The term of office is indefinite. The compensation, which is fixed by the commission, is an annual salary of $2,500.

The clerical force consists of one clerk and two stenographers, appointed by the director and the appointments approved by the executive officer. The salaries range from $30 to $50 a month. Up to the present time students in the State University have been employed in this capacity. In general, student help has been found very satisfactory.

The geologic assistants consist of an assistant director at a salary of $1,500 a year, a chemist at a salary of $1,200 a year, a draftsman at $900 a year, and assistant geologists, usually professors in the State University of Oklahoma, or other schools of equal rank, who serve at salaries varying from $75 to $125 a month. Field assistants, chiefly students at the university or members of the faculty in the State normal schools, receive salaries ranging from $20 to $30 a month in addition to their expenses while in the field. All assistants are appointed by the director subject to approval by the executive officer.

APPROPRIATIONS.

The appropriations for the Survey are made biennially by the legislature. Estimates for the work of the Survey for two years are prepared by the director and submitted by the executive officer to the state auditor, who lays the matter before the chairman of the appropriation committee. Appropriations thus far have not been contingent on cooperation, but it is hoped that such appropriation may be made at the coming session of the legislature.

Unexpended balances lapse into the State treasury at the end of the fiscal year. The annual appropriations for the Survey for the year ending June 30, 1910, were as follows:

Salaries	$7,780
Office and incidental expenses	2,590
Traveling expenses	800
Printing	2,075
	13,245

The annual appropriations for the biennium ending June 30, 1913, are as follows:

Salaries	$7,480
Office expenses	3,000
Field expenses	3,000
Cooperation	3,000
Printing	2,400
	18,880

The energies of the Survey have been expended largely in the preparation of bulletins on economic resources. Particular attention has been paid to oil, gas, asphalt, coal, clays, road material, Portland cement, lead, zinc, gypsum, and salt. Bulletins on these subjects have either been submitted for publication or are in course of preparation. In addition to the economic reports, a small amount of stratigraphic work has been carried on. The chemical laboratories are being fitted for the analysis of water and of mineral specimens. Considerable time is given to the investigation of road materials,

but none to highway work. No topographic work nor investigations of the underground water resources have been undertaken.

Two lines of work which bid fair to become extremely popular in Oklahoma have been undertaken by the Survey. The first is the preparation of an exhibit of the mineral resources of the State for the Oklahoma State fair, and the second is the collection of mineral specimens for the high schools, normal schools, and small colleges in the State. The Survey has assembled well-classified and comprehensive collections of 75 specimens of the rocks, fossils, and minerals of Oklahoma, and these are loaned to the schools. About 50 sets have already been sent out and applications are on file for a number of others.

The Survey is constantly in receipt of requests asking for a member of the staff to examine certain localities with a view to ascertaining the probabilities of minerals being found there. It has been found impossible to comply with all requests which have come to the office, and the petition plan has been adopted. The following blank is sent out to each applicant:

---------- Oklahoma, ----------

To the Director of the Oklahoma Geological Survey:

We, the undersigned freeholders of the county of ----------, State of Oklahoma, do hereby petition that a competent geologist be sent to this county to examine and report upon the following-described lands, to wit: ----------

---

We have reason to believe the following minerals may be found upon these lands: ----------

---

When a petition is signed by 50 taxpayers of a community and is certified by the county clerk a member of the Survey visits the locality, makes an examination, and submits a report thereon.

PUBLICATIONS.

Up to the present time the Survey has published only one bulletin, entitled "Preliminary report on the mineral resources of Oklahoma," but the following additional bulletins are either in press or ready for submission to the printer: "Preliminary report on asphalt," "Mineral resources of the Arbuckle Mountains," and "Preliminary report on coal."

The edition of the Survey publications is 3,000 copies. The size of the page is 6 by 9 inches.

The bulletins are distributed free of charge, except that in some cases extra postage is requested. The Survey having been organized for only two years, it is impossible to give the average cost of printing

reports and maps. The appropriation for printing for the present biennium is $4,175.

The contract for printing must be let by the State board of public affairs. The specifications, as to the style of report, illustrations, contents, etc., are prepared by the Survey. Bids are requested and the contract is awarded to the lowest bidder. If the appropriation is not sufficient to cover the cost of publication according to the specifications it is necessary to reduce either the number of illustrations or the number of copies to be issued.

The Survey has full control over the distribution of reports. Its policy is to distribute them, first, to other State surveys and to scientific organizations throughout the world; second, to manufacturers and business men particularly interested in the subject matter of the report; and third, to newspapers and prominent citizens of the State. In this connection it may be said that the issue of 3,000 copies of Bulletin 1 is practically exhausted.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

The Oklahoma Geological Survey is devoting its energies chiefly to investigations of the mineral resources of the State. During the last two years the oil and gas fields, clays, building stones, and structural materials have been studied. At present the coal, gypsum, glass sand, salt, lead, and zinc resources are receiving attention.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—At present the Oklahoma Survey is cooperating with the Federal Survey in the preparation of a geologic folio covering the Nowata and Pawhuska quadrangles. The Pawhuska quadrangle was surveyed by the Federal organization in 1909; the Nowata quadrangle was surveyed in 1910, under the direct supervision of Prof. D. W. Ohern, of the department of geology at the Oklahoma State University.

United States Office of Public Roads.—The Oklahoma Survey has cooperated with the United States Office of Public Roads at Washington in collecting and testing samples of road-building materials. An engineer detailed by the Roads Office spent several weeks in company with the chemist of the Oklahoma Survey investigating the road-building materials of the State. The tests of these materials have been made in the laboratories at Washington and the reports have been properly distributed.

Other State geological surveys.—Up to the present time the only cooperation with the geological surveys of other States has been with the Kansas Geological Survey. Prof. J. W. Beede, who has

worked on the Permian problem in that State for a number of years, has spent some time in Oklahoma studying the rocks of this interesting series. It is hoped that during the coming year cooperation may be carried on with the Missouri and Arkansas surveys.

Other scientific bureaus of the State.—Cooperation with the Oklahoma State Board of Agriculture and the park boards and water-supply commissions of the cities of Oklahoma has been arranged for and in several instances carried out. The people of Oklahoma are learning to look more and more to the Survey for accurate data regarding the State's natural resources.

PENNSYLVANIA.

PREVIOUS SURVEYS.

FIRST GEOLOGICAL SURVEY.

Through the instrumentality of the Geological Society of Pennsylvania an act providing for a Geological Survey of the State was reported to the legislature in 1832, but failed to pass. It was resubmitted annually for several years, and each year received the same treatment until, under the urgent demands of the people, the legislature passed it May 29, 1836. The act authorized an annual appropriation of $6,400 for five years. Prof. Henry Darwin Rogers, formerly State geologist of New Jersey, was appointed State geologist. During the first year the general geologic features of the State were determined and the Paleozoic section was divided into 12 formations, numbered from I to XII. This numerical nomenclature was used in the Pennsylvania publications for many years. No. I was the limestone at Harrisburg and No. XII the coal measures. In this first year also an understanding was obtained of the anticlinal and synclinal folds which are so conspicuous a feature of the geology of the State.

In the second year of the Survey detailed work was begun in the anthracite region, and in the third year nine assistants were scattered over the State, each man assigned to a district. This third season's work resulted in the discovery that the coal measures of western Pennsylvania are divided into two series, and that the bituminous coal field is characterized by folds and basins, but with a simpler structure than those in the central part of the State.

The Survey continued its work until 1841, but as the people could not see that they were getting what they wanted out of it, the legislature failed to make an appropriation in 1842. For three years, however, Mr. Rogers continued to prepare reports without remuneration from the State. In 1848 he submitted a final report, but it was not until 1851 that publication of the report was authorized. The

work being then 10 years old the legislature made an appropriation to cover the cost of the field work necessary to bring the report up to date and to defray the expense of its publication. From 1851 to 1854 field work was carried on each season, but it was not until 1858 that the final report of the Survey appeared. It consists of two quarto volumes, containing 1,631 pages, with numerous illustrations.

The publications of the first Geological Survey consisted of six annual reports, dated from 1836 to 1842, and the aforementioned final report.

SECOND GEOLOGICAL SURVEY.

A bill authorizing the inauguration of a new State Survey and the appointment of a board of commissioners passed the legislature May 14, 1874. The board selected the professor of geology in the University of Pennsylvania, J. P. Lesley, for State geologist. As a reconnoissance geologic survey of the entire State had already been made and the general geology was known with a fair degree of accuracy, the problems to be undertaken under Lesley's direction were well understood and plans were wisely formulated. The new Survey was to study the details of special geologic problems or special areas rather than the broad geologic features of the entire State. The principal work of the organization was the solution of economic problems, particularly of structural details and of the extent of the coal and petroleum formations. The plans adopted provided for (1) the occupation of five specially important and hitherto little-studied districts of the State requiring immediate attention; (2) the postponement of work in the best-known anthracite and bituminous coal regions; (3) the postponement of extensive systematic study of fossils; (4) the establishment of a special laboratory at Harrisburg for the analysis of irons, steels, iron ores, and other blast-furnace stock; (5) the preparation of a special report on petroleum; (6) the preparation of a special report on the mineralogy of the State; (7) the publication of the results of the summer's work during the following winter; and (8) the exhibition of type specimens of the Survey collections in the rooms of the board at Harrisburg.

During the 13 years that the Second Survey existed annual appropriations were made which amounted to $545,000. Among those who were regularly employed, or undertook special investigations in association with Prof. Lesley, were C. A. Ashburner, C. E. Beecher, J. C. Branner, J. F. Carll, H. M. Chance, E. W. Claypole, E. V. d'Invilliers, L. G. Eakins, Persifor Frazer, F. A. Genth, C. E. Hall, T. Sterry Hunt, A. E. Lehman, Leo Lesquereux, A. S. McCreath, F. Prime, jr., J. J. Stevenson, I. C. White, Arthur Winslow, and G. F. Wright.

Work was prosecuted over the whole State, particular attention being given to the oil region, the bituminous coal fields, and the anthracite fields. The anthracite fields were the subject of most exhaustive studies, detailed topographic maps being made on which the geology was laid down with the greatest care. Of this work David White says: "The atlas of the southern anthracite field in Pennsylvania represents the most minutely detailed and most excellent economic work of sedimentary deposits that has yet been accomplished over an extensive area in this country."

The reports of Lesley and his associates were published as rapidly as they could be prepared, and proved of such value to the public that the Survey maintained popular favor and continued to receive appropriations until 1887. The results of the 13 years of the Second Survey are contained in 77 octavo volumes of text, with 35 atlases, and a "grand atlas." These were followed, in 1893 and 1895, by the three octavo volumes constituting the final report, with the publication of which the Second Geological Survey came to an end. The black cloth-bound volumes of this Survey are a familiar sight in geologic libraries, but the State no longer has any of these reports for distribution. They can be obtained only from dealers in second-hand books. These volumes are designated by letters and figures. The letters seem to denote the sequence of inception of work in different areas, or different problems, and the figures or repeated letters indicate the order of subsequent reports on the same area. All volumes bearing the same letter relate to a particular area. For instance, all volumes lettered "G" deal with the northeastern part of the State, and those lettered "K" discuss the southwestern part. The sequence "G," "G2," "G3," to "G7" shows the chronologic order of completion of the reports. The "G" report was begun after the "F" report, but the "G7" report was completed before the "FF" or "F2" report. Atlases are indicated by parentheses surrounding the letter; thus "G3" designates the text of a report on Lancaster County and "(G3)" the atlas to accompany it. For ready reference to the reports it is necessary to consult an index map, usually found in the front of each volume, showing the letters designating reports on different parts of the State.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present Survey is entitled the Topographic and Geological Survey. It was organized under laws of 1899 and 1909.

SUMMARY OF LAWS AND ORGANIZATION.

The present survey was established in 1899, by an act of the legislature entitled "An act to authorize the topographic and geological

survey of the State in cooperation with the United States Geological Survey," which reads as follows:

SECTION 1. Be it enacted, etc., That the governor be, and he is hereby, authorized to appoint a commission, to consist of three citizens of this State, to confer with the Director or representative of the United States Geological Survey and to accept its cooperation with this State in the preparation and completion of a contour topographic and geological survey and map of this State, which is hereby authorized to be made. Said commission shall serve without pay, but all its necessary expenses shall, on approval by the governor, be paid out of the State treasury. Said commission shall have power to arrange with the Director or representative of the United States Geological Survey concerning this survey and map, its scale, method of execution, form, and all details of the work, in behalf of this State, and may accept or reject the work executed by the United States Geological Survey. And it is hereby provided that said map shall accurately show the outlines of all townships, counties, and extensive wooded areas in this State, as existing on the ground at the time of the execution of these surveys; the location of all roads, railroads, streams, canals, lakes, and rivers; and shall show by contour lines the elevation and depression of the surface of the country, also location of coal, oil, natural gas, and clay-bearing formations.

SEC. 2. For the prosecution of this survey, the sum of $20,000 is hereby appropriated for the year 1899 and $20,000 for the year 1900; and the auditor general is hereby authorized to draw his orders on the State treasury for such portions of these amounts as may be required, from time to time, from money in the treasury not otherwise appropriated, upon vouchers signed by two members of the commission; but it is hereby provided that these expenditures shall not be in excess of the amounts expended upon the same work by the United States Geological Survey from its own funds. The commission shall report to the governor each year. For the purpose of making the surveys hereinbefore provided for, it shall be lawful for the persons employed in making the same to enter upon all lands within the boundaries of this State, but this act shall not be construed as authorizing any unnecessary interference with private rights.

SEC. 3. This act shall be in effect immediately upon its passage.

Approved April 28, 1899.

The principal object contemplated by the act was the preparation of a topographic map of the State. The governor appointed as the commission G. W. McNees, Simon Harrold, and Fred D. Barker, whe entered into the following agreement with the Director of the United States Geological Survey:

Agreement between the Topographical and Geological Survey Commission of the State of Pennsylvania and the Director of the United States Geological Survey, for the cooperative topographic and geologic survey of the State.

1. The preparation of the maps shall be under the supervision of the Director of the United States Geological Survey, who shall determine the methods of survey and map construction, in accordance with the act of assembly of the State of Pennsylvania, entitled "An act to authorize the topographic and geologic survey of the State in cooperation with the United States Geological Survey," approved April 28, 1899.

2. The order in which in point of priority different parts of the State shall be surveyed shall be agreed upon in detail between said commission and said Director.

3. The work shall be based upon the triangulation of the United States Coast and Geodetic Survey, and, wherever this triangulation is deficient, it shall be supplemented by said cooperative survey.

4. The survey shall be executed in a manner sufficiently elaborate to prepare a topographic map upon the scale of 1:62,500 exhibiting the hydrography, hypsography, and public culture; said survey and map shall accurately show all township and county boundary lines (as established by the State laws at the time of their completion) and extensive wooded areas in this State as existing on the ground at the time of the execution of these surveys; the location of all roads, railroads, streams, canals, lakes, and rivers, and shall show by contour lines the elevation and depression of the surface of the country, also on geologic maps, the location of the coal, oil, natural gas, clay-bearing, and other geological formations. The said topographic maps shall be similar to the sheets already completed in this State, and the form of the final publications of the geological maps shall be the same as the Geological Atlas of the United States Geological Survey.

The preliminary field maps shall be on such a scale as said Director shall select to secure accuracy in the construction of the final map.

5. It is understood and agreed upon that the geological work shall follow the topographic survey as closely as consistent with economy and in accordance with modern scientific methods. The time of beginning this work to be agreed upon between the State Survey Commission of Pennsylvania and the United States Geological Survey.

6. The hypsography shall be shown by contour lines with vertical intervals of 20 feet, and the heights of important points shall be determined and marked upon fixed and permanent bench marks in important and prominent places throughout the counties; also, correct meridian points shall be located at each county seat and records furnished to the said commission.

7. For convenience, the United States Geological Survey shall, during the progress of the field work, pay the salaries of the persons employed therein, while the traveling, subsistence, and field expenses shall be paid for the same time by the State. For office work on the map the salaries shall be divided between the two agreeing parties in such a way as to equalize all expenses, provided that the total cost to the State of Pennsylvania of the field and office work and expense of said commission for the year 1899 and 1900 shall not be more than $40,000, and provided that the United States Geological Survey shall expend an equal amount.

8. During the progress of the work free access to the field sheets and records of the topographers and draftsmen shall be afforded the State commissioners for examination and criticism; and should they deem that the work is not being executed in accordance with this agreement, then the said commissioners may, on formal notice, terminate this agreement.

9. The resulting maps shall fully recognize the cooperation of the State of Pennsylvania.

10. As the work is completed, the State commissioners shall be furnished by the United States Geological Survey with photographic copies of the manuscript sheets; and, when the engraving, which is to be done at the cost of the United States Geological Survey, is completed, and at all times thereafter, when desired, the said commission shall be furnished by the said Survey with transfers at cost of printing from the copper plates of the photographic sheets for use in printing editions of said maps.

WASHINGTON, D. C., July 12, 1899.

Under the conditions of the foregoing act and agreement work progressed until half of the State has been mapped topographically and 37 quadrangles have been surveyed geologically, either by the Federal Survey alone or in cooperation with the State. Folios and bulletins descriptive of the geology of several of these quadrangles have been published by the United States Geological Survey.

In 1909 the legislature passed the following act:

An act authorizing the Topographic and Geological Survey Commission of Pennsylvania to establish and maintain a Topographic and Geological Survey of the State, fixing salaries, providing for the printing and binding of the results of said Survey, the furnishing of supplies and stationery, and making an appropriation therefor.

SECTION 1. Be it enacted by the senate and house of representatives of the Commonwealth of Pennsylvania in general assembly met, and it is hereby enacted by the authority of the same, that the Topographic and Geological Survey Commission of Pennsylvania is hereby authorized to establish and maintain a Topographic and Geological Survey of the State.

SEC. 2. The object of such Survey shall be as follows: The preparation and completion of a topographic map or maps of the State, also the study of its geological formation, with special reference to the economic development of its resources, such as coal, ores, oil, gas, stones, cement material, and all other minerals.

With these ends in view, the said Commission may and is hereby authorized to arrange with the United States Geological Survey or such other national organization as may be authorized to do such work for its cooperation, provided that the amount of money to be expended in such cooperative work on behalf of the State shall not exceed the amount so expended by such national organization.

The preparation of reports, with the necessary geological and other maps to properly illustrate the same, which shall be of such detail character and style of publication as the said Commission may deem best suited to properly describe the resources of the State.

SEC. 3. The reports of the said Survey shall be printed by the department of printing and binding in such form and style as may be designated by the Topographic and Geological Survey Commission.

SEC. 4. The said Commission shall serve without pay except the chairman of the same, who shall receive a salary of not more than $1,500 per annum, and the necessary expenses of said Commission shall be paid out of the State treasury after the same have been submitted in itemized form to the auditor general and approved by him.

SEC. 5. The said Commission shall appoint a State geologist, who shall be in immediate charge of the work of said survey, subject to the regulations and orders of said Commission.

The said geologist shall receive a salary not to exceed $3,000 per annum. He may also appoint such assistants as in the judgment of such Commission may be proper and necessary.

SEC. 6. In addition to the reports hereinbefore authorized, the said Commission shall make a biennial report to the governor and the legislature showing the progress and condition of the work, together with such other information and recommendations as the said Commission may deem necessary and useful.

SEC. 7. All specimens and materials collected shall, after serving the purposes of the Survey, be deposited in the State Museum and there preserved in such form as to be available for study in the further work of the Survey, or by individual students, but must not be removed from said Museum except for study and use by the State geologist or those working under his direction.

SEC. 8. All supplies and stationery, blank books, forms, or other printed matter necessary for the use of said Survey shall be furnished by the department of printing and binding or the department of public grounds and buildings upon requisition of said Commission.

SEC. 9. It shall be lawful for any and all persons employed in carrying on the work of the said Survey to enter upon and cross all lands within the State, provided that in so doing no damage shall be done to private property.

SEC. 10. The sum of $35,000 annually [afterward changed to $10,000 annually, or a total of $20,000] for the term of two years is hereby appropriated for the use of said Commission in carrying on the work authorized by this act.

SEC. 11. This act shall be in effect on the 1st day of June, 1909.

SEC. 12. All laws or parts of laws inconsistent with this act are hereby repealed.

This act of 1909 authorizes the State Topographic and Geological Survey Commission to do topographic and geologic work independently of the United States Geological Survey. On its passage the Commission appointed Richard R. Hice, of Beaver, as State geologist, and he still retains the position. Cooperation with the Federal Survey in topographic work has been continued, but geologic work is now being done independently.

The personnel of the Topographic and Geological Survey Commission in 1910 was as follows: G. W. McNees, of Kittanning (chairman); A. S. McCreath, of Harrisburg; and E. V. d'Invilliers, of Philadelphia.

During the first year of the organization under the new act (1909–10) permanent assistants were not appointed, the work being done on a per diem basis. So far as possible, college professors and advanced students who are residents of the State are employed in the work. Appointments are made by the State geologist. There is no civil-service commission to provide an eligible list or impose restrictions. In 1909 and 1910 the State geologist employed five geologists and two clerical assistants.

APPROPRIATIONS.

Appropriations are biennial and unexpended balances do not carry over. The total appropriation for the biennium 1909–1911 was $20,000, or $10,000 annually, about half the usual appropriation, and as it was to cover all topographic and geologic work the progress of the Survey has been greatly retarded. More than half of the sum was expended in cooperative topographic work.

The appropriation which is asked for by the Commission for the next biennium will be divided as follows:

	Per cent.
Administration and routine work	15
Topography (in cooperation with United States Geological Survey)	40
Economic, stratigraphic, and areal geology	35
Water resources, stream flow, etc	10

It is not at present intended to do any work on statistical geology, on paleontology as distinct from stratigraphy, or on the drainage of flooded districts. Chemical work will be included under geology. Highway work, testing road materials, and other technologic investigations are not contemplated for the coming year.

PUBLICATIONS.

The Commission proposes to publish three kinds of reports—(1) a series of biennial reports to the legislature giving a statement of the work accomplished and probably accompanied by short scientific papers (three of these biennial reports have been issued); (2) detailed reports on special subjects; and (3) short bulletins on special subjects. No reports of the second and third classes have been published.

Practically all geologic work done since the establishment of the Commission in 1899 has been in cooperation with the United States Geological Survey, and the reports have been published by that bureau.

The printing of State Survey publications must be done by the department of printing and binding, and while they conform in a general way to other State publications, the form and style are left to the Commission. The cost of printing reports does not come from the Survey appropriation and the department of printing and binding furnishes all supplies, such as stationery, blank books, forms, and other printed matter, on requisition of the Commission.

Reports are sent as exchanges to other surveys and organizations and are distributed to educational institutions and libraries within the State, and to citizens to whom they are of interest. Distribution is free, except postage in some cases.

Seven more or less detailed reports are in process of publication, in addition to two oil and gas reports resulting from cooperative work. These include papers on talc and serpentine in Pennsylvania, preliminary investigation of the cement resources and industry of Pennsylvania, graphite in southeastern Pennsylvania, paint ores of the State, and relation of the fresh-water fauna to geologic development, and a bibliography of Pennsylvania geology.

PRESENT LINES OF WORK.

Topographic work is being done in cooperation with the United States Geological Survey, and also geologic work on a number of quadrangles. There is at present no other cooperation with National or State bureaus. The geologic work being done by the Survey independently is chiefly of an economic nature.

RHODE ISLAND.

HISTORICAL SUMMARY.

In the later part of the thirties the increasing desire of the people to know more about the natural resources of the States culminated in Rhode Island in the formation of a State Survey which, in common with the times, was both geologic and agricultural in its purpose. The organization of this Survey was largely due to the efforts of the Rhode Island Society for the Promotion of Domestic Industry, which in December, 1838, appointed four men to confer with the committee appointed by the general assembly and appropriated $500 of the society's funds, provided the State should appropriate the balance necessary to conduct a survey of the State. Accordingly, at the session of the general assembly in 1839 a resolution appropriating $2,000 was passed, this sum to be expended under the direction of a committee of six from the general assembly and four from the Rhode Island Society for the Promotion of Domestic Industry. The members of this committee were to serve without compensation.

Dr. Charles T. Jackson, geologist of the State of Maine and member of many scientific societies both here and abroad, was asked to make the survey, and the contract with him was signed in April, 1839. His report, a volume of 312 pages, accompanied by map and geologic section sheet, was submitted to the committee May 25, 1840, and was published the same year. Criticism on the basis of our present geologic knowledge should not be made of the work done at that time. This report delimited the areas of the sedimentary and crystalline areas of the State, except where there had been considerable regional metamorphism, which was an unknown field to the geologists of that period.

In 1868 Prof. Thomas H. Ridgeway presented to the house of representatives a memorial upon the economic value of the so-called "Cranston" coal beds, recommending the construction of iron blast furnaces and the utilization of the natural resources of the State.

In January, 1875, a resolution was passed authorizing the governor to appoint a commission of five, three from the general assembly and two from the Providence Franklin Society, to prepare a plan for a thorough geologic and scientific survey of the State, to make esti-

mates, and, if possible, to report to the next general assembly. The expenses of this committee were to be paid from an appropriation of $500. This committee recommended to the general assembly the following plan:

1. The formation of a permanent board to have charge of the survey.
2. The appropriation of $5,000 annually for four years to complete the topographic plane tables of the State.
3. The publication of a map on the scale of 1:40,000.
4. A geologic survey of the State to be made under the direction of an able geologist appointed by the board, according to plans to be decided upon by it hereafter.
5. A further survey of the natural history of the State to be recommended to the general assembly after the completion of the geologic survey.
6. The submission to the general assembly of an annual report.

There is no record of any action taken on the report of this commission. Apparently those interested in the geologic survey of Rhode Island were so discouraged by the failure of this last attempt that there is no record of anything further being done for about 20 years.

Topographic surveys of the State and coast surveys of Narragansett Bay were published from the time of the settlement, through the Revolution, and up to 1892. Dr. Jackson, however, was obliged to rely on a coast-survey chart of Narrangansett Bay, published by the Hydrographic Branch of the Navy, 1832; the Stevens map of the State, published in 1831; and Nelson's survey of Cumberland, published by Aaron White. The need for a topographic map of the State was apparent. Many disputes were centered about the question as to the highest point in Rhode Island, Mount Hope, with an altitude of 200 feet, having the largest number of supporters, though hills in the western uplands are now known to be much higher. The matter was brought to the attention of the general assembly at its session in 1888 by a bill which provided for the appointment by the governor of three commissioners, "citizens of the State qualified by education and experience for such a survey," to serve without compensation, but to be provided with funds for their necessary expenses. This commission had the power of conferring with the United States Geological Survey regarding the completion of a contour topographic map, and a sum not to exceed $5,000 was appropriated in addition to the necessary expenses. The additional sum of $3,500 was appropriated in April, 1889, and $1,000 in April, 1891, for the preparation and publication of a wall map and atlas. Of each appropriation more than $100 was returned to the State treasury as an unexpended balance.

In May, 1895, the general assembly appointed a committee of four to provide for a geologic survey of the portions of the State contain-

ing rocks adapted to road making, and the sum of $1,000 was appropriated for that purpose. Frederick P. Gorham, then a graduate student at Brown University, was selected to do this work, and he prepared a sketch geologic map of the State and three sets of specimens illustrating the different rock types in Rhode Island. No report of this work, however, was ordered printed by the legislature.

In 1904 a bill was introduced into the general assembly providing for a geologic survey, $3,000 to be appropriated for the purpose, but the bill was not reported back to the house from the committee to which it was referred.

In 1908 a bill providing for a geologic survey of Rhode Island was prepared by former Lieut. Gov. F. H. Jackson. A hearing was given on this bill, but it did not pass the general assembly.

The following year a law was enacted making provision for the present Natural Resources Survey of Rhode Island and appropriating $2,500 annually for three years for its use. The work was placed under the general charge of the commissioner of industrial statistics, where it remained until August, 1910, when it was placed under the direction of the newly created Conservation Commission.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is the Natural Resources Survey of Rhode Island; it was organized under laws of May 10, 1909, and August, 1910.

SUMMARY OF LAWS.

Chapter 438 of the public laws of the State of Rhode Island, 1909, passed May 7, 1909, and signed three days later, is as follows:

SECTION 1. A survey of the natural resources of the State shall be made. This survey shall be placed under the general charge of the bureau of industrial statistics, in cooperation with the Rhode Island State College and the Government of the United States of America.

SEC. 2. The bureau shall appoint a competent agent to take charge of the survey, at such compensation as the commissioner of the bureau may determine. The agent so appointed may employ suitable assistants as they may be needed for the proper prosecution of the work of the survey, with the advice and consent of the commissioner of the bureau.

SEC. 3. The survey shall be made so as to embrace the following matters, viz:

1. An examination of the geological formation of the State, with special reference to its economic resources, viz, road material, building stones, clays, coals, and other mineral substances.

2. A detailed examination and classification of the soils, and a study of their adaptability to particular crops, together with an examination of the waste lands of the State, and the bearing it may have upon water powers, potable waters, and the relation of deforested areas to such water supplies.

3. An examination of the physical features of the State, with reference to their practical bearing upon the occupation of the people.

4. The preparation of special geological and economical maps to illustrate the resources of the State.

5. The preparation of special reports, with necessary illustrations and maps, which shall embrace both a general and detailed description of the geological and natural resources of the State.

6. A report upon the fishery industry of Narragansett Bay and its tributary waters.

7. The consideration of such other scientific and economic questions as in the judgment of the commissioner and the Rhode Island State College shall be deemed of value to the people of the State.

SEC. 4. An annual report of progress to be made to the general assembly, or upon their request.

SEC. 5. Reports and maps to be printed by direction of the commissioner upon recommendation of agent and the Rhode Island State College; to be distributed or sold by said commissioner; moneys to be returned to State treasury.

SEC. 6. Distribution of material collected; to be finally distributed by the commissioner and the Rhode Island State College to the educational institutions of the State, or placed upon permanent exhibition.

SEC. 7. An annual appropriation of $2,500 for a period of three years to be paid by the State upon itemized vouchers approved by the governor.

SEC. 8. This act shall take effect upon its passage.

The following bill (chapter 644, public laws of Rhode Island) became a law during the August session, 1910, and the general charge of the Survey passed from the commissioner of the Bureau of Industrial Statistics to the State Conservation Commission, but practically without change in the administration of the Survey.

SECTION 1. There shall be a State Conservation Commission of five members, consisting of the Commissioner of Industrial Statistics, the director of the Rhode Island Agricultural Station, the secretary of the State Board of Agriculture, the commissioner of forestry, and the secretary of the Metropolitan Park Commission of the Providence Plantations, ex officio, and their respective successors.

SEC. 2. Said Commission shall have general supervision and oversight of the matters pertaining to the conservation of the natural resources of the State, including the Natural Resources Survey established and authorized by chapter 438 of the public laws, passed at the January session, A. D. 1909, and shall act in an advisory capacity to the undertakings of this nature now in progress or which may hereafter be projected, provided same are not inconsistent with the law. It shall have authority to cooperate with similar commissions of other States and with the departments of the United States Government with which it may have occasion to enter into negotiations whenever it shall deem it advisable.

Section 3 provided for the organization of the Commission. In section 4 the main purpose of this Commission is stated. It is to make a census and list of the so-called "abandoned farms." The further powers of the Commission were rather comprehensive and include many lines of work already given to the State Survey. In section 5

the sum of $3,000 was appropriated. Section 6 provided that the Commission was to report on abandoned farms in January, 1911. Section 7 states that the Commission shall serve without compensation, except expenses.

SEC. 8. This act shall take effect upon its passage, and all other acts or parts of acts inconsistent therewith are hereby repealed. Nothing in this act shall be considered, however, as repealing or otherwise affecting any of the provisions of chapter 438 of the public laws of 1909 (creating the Natural Resources Survey) except as provided in section 2.

ORGANIZATION.

The governing board is the State Conservation Commission, information regarding which is given under "Summary of laws."

The executive officer is called superintendent. Prof. Charles W. Brown, head of the department of geology at Brown University, is the present incumbent. He was appointed by the commissioner of industrial statistics, who formerly had charge of the Survey, in June, 1909. His compensation is at a per diem rate and is fixed by the Commission. He devotes the summer months to field work for the Survey and a month or more of the college year to office work for the Survey.

Occasional clerical and stenographic assistance is employed by the superintendent, with the advice and consent of the Commission. There are no civil-service regulations, the only requirement being general fitness for the work. The compensation varies from $1 to $3.50 a day. The total amount of this sort of assistance would probably equal that of one person for half a year.

The geologic assistants are instructors or advanced college students at Brown University, who are employed for varying periods. Their compensation ranges from $1 a day to $75 a month and field expenses.

The only topographic work done by the Survey is the drafting of enlargements of existing topographic maps. No engineering work has been undertaken. Work on the water resources is done in cooperation with the United States Geological Survey.

APPROPRIATIONS.

The law of 1909 appropriated the sum of $2,500 annually for the period of three years, to be used for the purposes specified in the law. The average expenditures are about as follows:

	Per cent.
Administration and routine clerical work	30
Enlarging topographic maps, publication, etc	20
General geology	44
River measurements (1909)	6

PUBLICATIONS.

The only publication thus far has been Bulletin 1, a preliminary report giving in outline some of the data gathered, especially with reference to the water resources and coal. One thousand copies of this report were issued for free distribution.

The cost of the printing does not come from the Survey appropriation. The printing and distribution of publications is left to the superintendent and the commission.

The mailing list includes the State libraries, State surveys, departments of geology in prominent educational institutions, and interested persons.

PRESENT LINES OF WORK.

The present lines of work include a detailed classification of the occupied and unoccupied lands of Rhode Island, especially in the "abandoned areas;" the preparation of a detailed geologic map of the State; the publication of a series of educational bulletins on the geography, geology, and water resources of Rhode Island; and a comprehensive and detailed study of the soils of the State.

SOUTH CAROLINA.

PREVIOUS SURVEYS.

To South Carolina belongs the credit of having been among the first States to organize a State Geological Survey. Since the first Survey, which was authorized by the legislature in 1824, the statutes of the State have authorized four subsequent surveys. The first four surveys were created for specific periods and terminated at their expiration.

FIRST GEOLOGICAL SURVEY.

The first Survey was known as the Geological and Mineralogical Survey of South Carolina. The work was in charge of Lardner Vanuxem, who served as State geologist of New York and South Carolina. The report of this Survey was published in the newspapers of the State in 1826, and in part in Mills's "Statistics of South Carolina" and in Tuomey's "Report on the geology of South Carolina." This report contained a list of minerals from the Abbeville, Pendleton, Greenville, Spartanburg, and York districts. It was the first geologic report issued under the patronage of any State in the Union. In 1828 Dr. S. G. Morton and Mr. Vanuxem pointed out the existence of "Secondary" (Mesozoic) and Tertiary formations in the State.

SECOND GEOLOGICAL SURVEY.

Under the second Survey Edmund Ruffin was State geologist. His report, entitled "Report of the commencement and progress of the agricultural survey of South Carolina," was published in 1843. It relates chiefly to the subject of marls as soil stimulants, but also includes a list of invertebrate fossils of the State, and contains numerous analyses of the marls.

THIRD GEOLOGICAL SURVEY.

Under the third Survey Michael Tuomey was State geologist. His first report, entitled "Report of the geological and agricultural survey of the State of South Carolina," a pamphlet of iv+63 pages, was published in 1844. This was followed, in 1846, by a report to the city council of Charleston, S. C., on artesian wells, and, in 1848, by a report on the geology of South Carolina. The latter report was a volume of 299 pages, with numerous illustrations and a geologic map of the State.

FOURTH GEOLOGICAL SURVEY.

During the fourth Survey (1856–1860) Oscar M. Lieber was State geologist. The publications issued by this Survey consisted of four annual reports to the general assembly, published in the years 1856, 1858, 1859, and 1860. These reports varied in size from 144 to 238 pages and contained several illustrations. Two editions of the first report were issued.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is the South Carolina Geological Survey; it was established under an act approved February 21, 1901.

ORGANIZATION.

There is no governing board. The executive officer is the State geologist. The present incumbent is Earle Sloan, who was appointed April 30, 1901. His present term expires April 30, 1911. The compensation of the State geologist is an annual salary, the amount of which is fixed by statute.

The only office assistant is a stenographer. The field assistants consist of a captain of field camp and laborers. Chemical work is done in the State laboratory, located at Clemson College, and for this work a liberal appropriation is made by the legislature.

APPROPRIATIONS.

The South Carolina Geological Survey receives an annual appropriation of $3,400. There is no law regulating unexpended balances; in fact, the appropriation is usually exceeded.

As construed by the State geologist, expenditures under the law may be directed to economic, stratigraphic, areal, statistical, and paleontologic geology. The expense of chemical work is provided for under the appropriation for the State laboratory and does not come out of the Survey appropriation. A bureau of information is maintained, relating to geology, technology, and many other subjects.

PUBLICATIONS.

The publications of the Survey comprise (1) a series of annual administrative reports (3 to 5 pages), summarizing the scope and general results of investigations, and (2) a series of bulletins in which detailed results of special studies are given. Of the bulletins four have been issued or are in press, one on the clays of the State, one on the geology and mineral resources, one on the marls and other coastal plain formations, and one on the underground waters.

All official publications are printed by the State printer. Copies for officers of the State and members of the legislature are published in accordance with a general statutory provision. Copies of the geologic reports in excess of this number are paid for from the appropriation for the Geological Survey or from the private resources of the State geologist. The size of page, kind of paper, illustrations, and contents of report are left to the State geologist.

The reports are distributed by the State geologist. They are sent to scientific bodies, educational institutions, men of science, and, on application, to persons manifesting active interest in the industrial development of the mineral resources of the State.

PRESENT LINES OF WORK.

Independent investigations.—At present the energies of the Survey are directed chiefly to investigations of the phosphate deposits and peat deposits of the State.

Cooperation with United States Geological Survey.—In cooperation with the Federal Survey an areal and economic survey of the Kings Mountain and Gaffney quadrangles is being made, the results of which will be combined into one geologic folio. The field work for this folio will be completed during the field season of 1911. These two quadrangles form the key to the geology of a large part of the Piedmont region.

Cooperation with the Federal Survey has also been maintained in the preparation of reports on the geology and underground water

resources of the coastal plain of South Carolina, which are now in an advanced stage. These will be published as bulletins of the State Survey.

TENNESSEE.

PREVIOUS SURVEYS.

State geologic work in Tennessee began in December, 1831. An address delivered before the State legislature on October 19, 1831, by Dr. Gerard Troost, resulted in the passage of a law authorizing the survey, and on December 21, 1831, Dr. Troost was appointed geologist, mineralogist, and assayist of the State. He held this position until it was abolished by the legislature February 4, 1850. Dr. Troost was also professor of geology and mineralogy in the University of Nashville, from which he received a salary of $1,000 a year. He received from the State $250 for the first two years and $500 annually for succeeding years. Out of his salary he paid traveling and other field expenses. During his term of office Dr. Troost prepared 10 reports. The first two reports do not appear to have been published, and of the last only 75 copies were issued, none of which appear to be extant.

In February, 1854, the legislature again created the office of geologist and mineralogist of the State, and Prof. J. M. Safford was elected to the position. The survey was continued until 1860, when active work was stopped by the civil war. Prof. Safford, however, continued as State geologist by courtesy to the time of his death, a few years ago. In March, 1868, the legislature authorized the preparation of a report and ordered it printed. This report embodied the results of Prof. Safford's work, both as the official State geologist and as a private citizen. During his term of office he published a preliminary geologic report of the State of Tennessee, consisting of 164 pages, and the report authorized in 1868, which was more detailed, consisting of 550 pages.

In 1874 J. B. Killebrew, as secretary to the State Board of Agriculture, prepared a report of 1,193 pages on the resources of Tennessee. This volume includes a general review of the geology and agriculture of the State and of the agricultural and mineral resources, also a detailed review by counties.

Upon the appointment of Prof. L. C. Glenn to the chair of geology in Vanderbilt University, in 1900, he at once began an agitation for a State Geological Survey. His efforts in that direction were supplemented by Prof. C. H. Gordon, on his appointment, in 1906, as professor of geology at the University of Tennessee. The result of the efforts of these geologists, supplemented by a demand from practical mining men and others, was the authorization of the present State Geological Survey by the legislature in 1909.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is the Tennessee State Geological Survey; it was established under act of April 30, 1909, which was approved May 1, 1909, but the appropriation did not become available until May 1, 1910, when the Survey began its official existence.

SUMMARY OF LAWS.

The State Geological Survey is under the direction of a commission known as the State geological commission, composed of the governor (ex officio chairman), the State commissioner of agriculture, the State mine inspector, the president of the University of Tennessee, the chancellor of Vanderbilt University, and the vice chancellor of the University of the South. This commission has general charge of the Survey and the appointment of a State geologist and, on his recommendation, of associate geologists, assistants, and other employees. The State geologist is directed to organize and direct the work; to determine the character, order, and time of publication of the reports; to direct the preparation, printing, and distribution of the reports; to arrange for cooperative work with Federal and State bureaus; to appoint associates, assistants, and employees; to have charge of the necessary field work, office supplies, and equipment; and to supervise the acquisition, care, and disposition of collections, etc. He is also to prepare a report to the general assembly for each meeting.

The State Geological Survey has for its objects and duties the study, mapping, and preparation of reports on the mineral resources, road-making materials, structural materials, sands, soils, forests, mineral and artesian waters, drainage of swamps, flow of streams, water powers, and other natural resources. The law provides for the distribution and sale of reports and for the care and final disposition of collections, reports, etc. It authorizes cooperation with other scientific bureaus, makes it lawful to enter and cross lands within the State, and provides an annual appropriation of $15,000 for the years 1910 and 1911 for carrying out the provisions of the act.

ORGANIZATION.

The governing board is the State geological commission, which has already been described under "Summary of laws." The terms of office of the members of the commission depend on their official terms of office or upon the continuance of the Survey. They receive no compensation except necessary expenses in connection with attending the meetings of the commission.

The title of the executive officer is State geologist, though in other places in the bill he is referred to as the director. The present incumbent is George H. Ashley, who was appointed by the commission March 16, 1910, to serve for two years. The compensation is an annual salary, fixed by the State geological commission.

The clerical force consists of one clerk.

In addition to the State geologist the commission at the same time appointed two associate geologists, Prof. C. H. Gordon, professor of geology at the University of Tennessee, and Prof. L. C. Glenn, of Vanderbilt University. The scientific staff of the Survey also includes two temporary assistant geologists, one of whom is a senior at the University of Tennessee and serves only during the summer vacation. The associate geologists devote to the Survey only such portion of their time as they can spare from their college duties. Their compensation is on a per diem basis.

The associate geologists were not required to submit to an examination; the assistants were also appointed without examination. All appointments are made by the State geological commission on the recommendation of the State geologist.

Cooperation with Federal bureaus is maintained, and it is the purpose of the Survey to devote a large part of the appropriation to cooperative work instead of building up a large independent State Survey.

APPROPRIATIONS.

The appropriations are made at the biennial sessions of the legislature, presumably for the two succeeding years, though the present, or first, appropriation was not available until a year after the bill was signed by the governor.

Unexpended balances carry over from the first to the second year but lapse at the end of the second fiscal year of the biennium.

The annual appropriation is $15,000, for the general objects outlined in the law. This is disbursed in approximately the following proportions:

	Per cent.
Administrative and routine clerical work	18
Economic, stratigraphic, and areal geology	38
Chemical work	1
Topographic maps and drainage surveys	20
Stream flow and reservoir surveys	3
Soil survey	4
Printing	16

PUBLICATIONS.

The publications of the Survey will all be in the form of bulletins. Where a bulletin is composed of several distinct papers, either on the same subject or on related subjects, part of the edition will appear as

separates, which will be issued as fast as they can be prepared and printed.

Two bulletins and five papers from other bulletins have already been issued.

The size of the edition is 3,000 copies.

Bulletins are to be distributed free to official surveys, public libraries, etc., and on request to interested persons. Five hundred copies of each publication are to be reserved for sale, at the cost of printing. The money derived from sales is to be paid back into the State treasury. Another 500 copies of each publication will be bound in the form of a library edition. In the case of the bulletins which are composed of more than one paper, 500 copies of each separate will be reserved until all the separates belonging to that bulletin have been issued, when they will be bound together into a single volume.

The cost of publications now in press is $2.65 to $3.50 a page. The expenses of publication are charged to the Survey's appropriation.

The State geologist has full control over the printing, choice of printer, style of report, etc., and also has charge of the distribution of reports.

The mailing list includes State officials, the United States Geological Survey, State surveys, and other bureaus operating along the lines of the Survey's work, the libraries of State universities and to a limited extent those of foreign surveys and national universities, all the regularly constituted libraries of the State, the members of the State legislature and other State officials, independent geologists who may be interested in the subject of the report, and any person who may have made specific request for reports on that subject. A printed card of acknowledgment is inclosed with each report sent out, and the responses will have some influence in determining the distribution of future reports.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

The Survey is at present engaged in a general study of the conditions and needs of the State, in a preliminary study of the coal field and the phosphate field of the State, in the preparation of a map of the economic geology of the State, in the preparation of a bibliography of literature relating to the State's resources, and in the formation of a permanent exhibit of the resources and minerals of the State. Preliminary bulletins treating of these subjects will be issued as rapidly as possible.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—In cooperation with the United States Geological Survey a detailed areal and economic survey of the Pikeville special quadrangle is being made. A preliminary report on the coal resources of this quadrangle will be published as a bulletin of the State Survey, and as soon as the adjoining quadrangle can be surveyed a geologic folio of the two quadrangles will be published by the Federal Survey.

A general study of the oil and gas development of the State has also been made in cooperation with the Federal Survey, the results being published as Bulletin 2 E of the State Survey.

Cooperation with the United States Geological Survey in topographic work is also maintained. The preliminary control of six 15-minute quadrangles in western Tennessee has been completed and the maps are in course of preparation. In cooperation with certain drainage districts, large-scale detailed topographic maps of some valleys of western Tennessee are also being prepared by the Federal Survey.

United States Department of Agriculture.—Cooperation is maintained with several bureaus of the United States Department of Agriculture. With the Drainage Investigations Division of that department a study of the drainage problems of western Tennessee is being made; with the Bureau of Soils a detailed soil survey of the Franklin 15-minute quadrangle is in progress; and with the Office of Public Roads information regarding the roads of the State is being collected.

Other scientific bureaus of the State.—Cooperative arrangements have been made with the State chemist of Tennessee and with the State Agricultural Experiment Station.

VERMONT.

PREVIOUS SURVEYS.

The first Geological Survey of Vermont was established in 1845 and was continued for three years. Prof. C. B. Adams was geologist in charge. Three annual reports and a supplementary pamphlet were printed and distributed. Much of the work was pioneer and of a general nature. None of the reports were extensive, but Prof. Adams hoped to issue a larger and more valuable final report. There was, however, never any appropriation for this.

The second Survey was begun in 1857 and continued until 1861. Dr. Edward Hitchcock was in charge of this Survey, and was assisted by his two sons, Edward Hitchcock, jr., and Charles H. Hitchcock, and by Albert D. Hager. The publications of this Survey consisted

of several reports of progress and pamphlets and a detailed report of considerable value, comprising two quarto volumes, well illustrated, which were published in 1861.

For several years after the publication of this report Mr. Hager, who appears to have had most to do with its preparation, held the office of State geologist, but there does not appear to have been any appropriation except $500 for the care of the State cabinet, which was also to cover expenditures for specimens, etc., needed for the cabinet.

In 1896 the legislature appropriated $1,500 annually for two years.

Rev. G. W. Perry was then State geologist. He made no report, and resigned on account of ill health in 1898, when the present State geologist, Prof. G. H. Perkins, was appointed. The present Survey really dates from that time, 1898. Between 1861 and 1898 no active geologic work was done in the State.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is the Geological Survey of Vermont; it was organized in 1898.

SUMMARY OF LAWS AND ORGANIZATION.

The governor biennially appoints a State geologist, the appointment being confirmed by the State senate. The appointee must have competent knowledge of geology. He is to give, on request, advice as to mines, quarries, etc., in the State; to publish biennially a report of the mineral industries and resources of the State; and to furnish the governor, on demand, information regarding the geology of the State. He is also the curator of the State cabinet.

There is no governing board. The State geologist is untrammeled in this respect. He has no permanent assistants, but may, within the limit of his appropriation, employ temporary assistants. He is paid a per diem rate and expenses. He is expected to attend the sessions of the legislature, and while in attendance receives the same pay as a member of the State assembly. He holds office until his successor is appointed and confirmed, but is by custom appointed biennially. The present incumbent is Prof. G. H. Perkins, who is also professor of geology in the State University. He has held the office since 1898.

APPROPRIATIONS.

The amount of the appropriation is $1,500 annually. It is a continuing appropriation, or until changed by direct legislative action. In addition there is an annual appropriation of $500 for the care and increase of the collections of the State cabinet, of which the State

geologist is the curator. All appropriations are expended as the State geologist determines, but are subject to the approval of the State auditor. They are devoted to economic, stratigraphic, and paleontologic work.

PUBLICATIONS.

Under the law the State geologist is required to publish a report biennially. There are no limitations as to the nature or size of the report. The reports usually consist of about 350 pages. The whole cost of publication is paid by the State. The size of the edition is 1,500 copies.

Each State officer and member of the legislature is entitled to a copy of each report, and 100 copies are sent to the State library. The rest of the edition is distributed by the State geologist. Very few copies are sold, chiefly to dealers who ask for it, when a nominal price ($1 to $1.50) is charged. All moneys received from the sale of reports are returned to the State treasury.

The average annual cost of publications during the last ten years, including illustrations, binding, and printing, has been about $1,000.

There is a printing commissioner, who places the printing, determines the quality of paper, etc., but the style of the report, the contents, illustrations, size, and most of the details are left to the State geologist.

The mailing list is determined wholly by the State geologist and is made up of libraries in the State and outside of it, of geological surveys of other States, and of any persons or firms interested in the subjects treated in the reports.

PRESENT LINES OF WORK.

The Geological Survey of Vermont has always worked independently of any other survey, because the State legislature has refused to make appropriation for cooperative work. Individually the State geologist has been connected with the United States Geological Survey. The energies of the Survey are directed to economic, stratigraphic, and paleontologic investigations.

VIRGINIA.

PREVIOUS SURVEYS.

The first Geological Survey of Virginia was authorized by an act of the general assembly in 1835 and continued through 1841, with Prof. William Barton Rogers, of the University of Virginia, as director. The publications of this Survey were issued as annual reports, entitled "Report of the progress of the Geological Survey of Virginia for the year 1835," etc. Large editions of these reports were printed, but were exhausted many years ago, and they have

now become extremely rare. Because of frequent requests for these reports, by geologists and others, Mrs. Emma Rogers, widow of Prof. Rogers, assisted by Maj. Jed. Hotchkiss, of Staunton, Va., and Prof. Rogers's brother, Dr. R. E. Rogers, in 1884 reprinted a limited number of copies of a quarto volume, entitled "A reprint of annual reports and other papers on the geology of the Virginias." The volume contains xv+832 pages, and is accompanied by a colored geologic map on the scale of 24 miles to the inch and more than 90 geologic sections.

Beginning in January, 1880, and continuing through 1885, a weekly journal was published at Staunton, Va., by Maj. Jed. Hotchkiss as editor, entitled "The Virginias: A mining, industrial, and scientific journal devoted to the development of Virginia and West Virginia." Six complete quarto volumes of about 200 pages each were published. These contain many valuable briefs and abstracts on mineral localities, mines, and mining statistics, and articles on the geology of Virginia and West Virginia.

Beginning in the summer of 1904 and continuing for a period of about two years (1906), a geologic survey of the mineral resources of Virginia, not authorized by the general assembly, was conducted jointly by the State Board of Agriculture and Immigration and the board of visitors of the Virginia Polytechnic Institute, with Prof. Thomas L. Watson as geologist in charge. As the result of this work the following three reports were published and distributed, one of which (Bulletin III) was prepared in cooperation with the United States Geological Survey:

Bulletin I. Lead and zinc deposits of Virginia, by Thomas L. Watson, 1905.

Bulletin II. The clay deposits of the Virginia coastal plain, by Heinrich Ries, with a chapter on the geology of the Virginia coastal plain, by W. B. Clark and B. LeR. Miller, 1906.

Bulletin III. Hydrography of Virginia, by N. C. Grover and R. H. Bolster, 1906.

In 1907 a large illustrated volume entitled "Mineral resources of Virginia" was prepared by Prof. Watson and published by the Virginia Jamestown Commission.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is the State Geological Survey of Virginia; it was organized in September, 1908, under an act approved February 25, 1908.

SUMMARY OF LAWS.

The first meeting of the State geological commission was held in the governor's office at Richmond on September 12, 1908, when the commission appointed the director and assistants and approved plans

for beginning the work. The organization of the Survey dates from this meeting, and systematic work was begun immediately thereafter. The objects of the State Geological Survey are briefly set forth in the following act:

Chapter 75. An act to establish a State Geological Survey and to make provision for the preparation and publication of reports and maps to illustrate the natural resources of the State, together with the necessary investigation preparatory thereto.

1. Be it enacted by the General Assembly of Virginia, That there be, and is hereby, created and established at the University of Virginia a bureau, to be known as a State Geological Survey, which shall be under the direction of a commission, to be known as a State Geological commission, composed of the governor (who shall be ex officio chairman of said commission), the president of the University of Virginia, the president of the Virginia Polytechnic Institute, the superintendent of the Virginia Military Institute, and one citizen from the State at large, who shall be appointed by the governor for a period of four years from June 1, 1908. The geological commission shall meet twice each year, once in January and once in June, in the city of Richmond, on the call of the governor, except that the commission may change the time and place of meeting as circumstances may require, and said commission may appoint a clerk to keep a record of its proceedings.

The said commissioners shall serve without compensation, but shall be reimbursed for actual expenses incurred in the performance of their official duties; and the said commissioners shall have general charge of the Survey, and shall appoint as director a geologist of established reputation, who may, with the approval of the commission, appoint such assistants and employees as may be necessary to enable him to carry out successfully and speedily the work of the Survey. The director appointed under the provision of this act, and the assistants and employees appointed by him, shall receive such compensation as may be determined by the commission.

2. The Survey shall have for its objects and duties the following:

(1) An examination of the geological formations of the State, with special reference to their economic products, namely, building stones, coals, ores, clays, soils, cement, materials suitable for use in the construction of roads, mineral and artesian waters, and other mineral substances.

(2) An examination of the road-building materials and the best methods of utilizing the same.

(3) An examination and classification of the soils and study of their adaptability to particular crops.

(4) An examination of the streams and water powers of the State, with special reference to their development for manufacturing enterprises.

(5) An examination of the water supplies of the State, with special reference to the sinking of deep or artesian wells.

(6) An examination of the physical features of the State, with reference to their practical bearing upon the occupation of the people.

(7) The preparation of special geological and economic maps to illustrate the resources of the State.

(8) The preparation of special reports, with necessary illustrations and maps, which shall embrace both a general and detailed description of the geology and natural resources of the State.

(9) The consideration of such other scientific and economic questions as in the judgment of the State geological commission shall be deemed of value to the people of the State.

(10) The said commission is hereby authorized to arrange with the Director or the representatives of the United States Geological Survey in regard to cooperation between the said United States Geological Survey and the said State geological commission in topographic, geologic, and hydrographic work in such instances as may be deemed necessary and of advantage to the State, provided that in all cooperative work a sum of money shall be expended by the said United States Geological Survey equivalent to that expended by the said State Geological Survey, and that the said commission may accept or reject the work of the said United States Geological Survey.

3. The commission shall cause to be prepared a report to the legislature before each meeting of the same, showing the progress and condition of the Survey, together with such other information as it may deem necessary and useful or as the legislature may require.

4. The regular and special reports of the Survey, with proper illustrations and maps, shall be printed as the commission may direct, and the reports shall be distributed by the said commission as the interests of the State and of science may demand.

5. All materials collected, after having served the purposes of the Survey, shall be distributed by the director to the educational institutions of the State in such manner as the commission may determine to be of the greatest advantage to the educational interests of the State.

6. The sum of $10,000 annually, or so much thereof as may be necessary, is hereby appropriated, out of any funds of the treasury not otherwise appropriated, for the purpose of carrying out the provisions of this act, to be paid out by the treasurer upon the warrant of the auditor of public accounts, which shall be drawn upon the certificate of the chairman of said commission.

Approved, February 25, 1908.

ORGANIZATION.

The governing body is the State geological commission, which is composed of five members, as stated in the law. The members of the commission serve without compensation, but are reimbursed, out of the appropriation for the Survey, for actual expenses incurred in the performance of their official duties.

The executive officer is called director. The present incumbent is Prof. Thomas Leonard Watson, who was appointed by the State geological commission in September, 1908, for an indefinite period. The director of the Survey is also the professor of geology in the University of Virginia. His time is divided equally between the Survey and the schools of geology in the University. He receives an annual salary, which is fixed by the State geological commission and paid in twelve equal installments.

Assistants include two assistant geologists, one chemist, and one stenographer. These are appointed by the director, with the approval of the State geological commission, and are paid monthly salaries. In addition to the permanent staff of the Survey, four

college professors are employed on a per diem basis, and since the organization of the Survey several advanced college students have been employed during each summer season.

APPROPRIATIONS.

Appropriations are biennial. No part of the appropriation is contingent on cooperation. Unexpended balances lapse to the State treasury immediately on the close of the year.

The amount of the appropriation is $10,000 annually, of which $1,750 is spent in topographic surveys in cooperation with the United States Geological Survey.

PUBLICATIONS.

The publications of the Survey consist of a series of bulletins, a series of biennial administrative reports, and maps. Of the bulletins five have been issued or are in press. One of these treats of the mineral production of the State for 1908, one of the cement resources of Virginia, one of the titanium and apatite deposits, one of the physiography and geology of the coastal plain of the State, and one of the underground water resources of the coastal plain of the State. Two maps have been issued, one showing the location of mines and quarries, and the other a geologic map of the State on the scale of about 8 miles to the inch.

The size of editions varies from 1,500 to 2,500, according to the subject and the probable demand.

Publications are mailed to libraries and to interested persons on receipt of postage.

The cost of printing is paid from the Survey appropriation, and the director has full charge of all matters pertaining to the printing. The director also has full control of the distribution of reports.

PRESENT LINES OF WORK.

Independent investigations.—The independent investigations of the Survey at present include the systematic study and mapping of the copper, gold, and iron deposits and of the building stones, road-building materials, and cement resources of the piedmont and coastal plain provinces of the State, and a report on the areal geology of middle western Virginia.

Cooperation with United States Geological Survey.—In cooperation with the Federal Survey a study has been made of the geology and underground waters of the Virginia coastal plain, the reports of which have been completed and are in press. Also in cooperation with the Federal Survey, four 15-minute quadrangles in the Virgilina copper district were covered by traverse, and a map, on the

scale of 1:24,000, has been prepared of the central part of the area included in these quadrangles.

Cooperation with other State surveys.—In cooperation with the North Carolina Geological Survey a joint study on the Virgilina copper district has been made and a report is now in course of preparation.

WASHINGTON.

PREVIOUS SURVEY.

At the first (1890) session of the legislature of the State of Washington two laws were passed providing for a State Geological Survey. One of these acts provided for the creation of the Mining Bureau and defined its powers and duties. The other act created the office of State geologist and prescribed the duties and compensation of that official. The Mining Bureau was composed, ex officio, of the governor, lieutenant governor, and State treasurer. These men, after organization, were to appoint the State geologist, with the advice and consent of the senate. The term of office of the State geologist was to be the same as that of the officers of the Mining Bureau, unless he was sooner removed for cause.

Among the duties of the State geologist were the collection of reliable statistical information concerning the production of minerals of economic value; the making of assays and analyses, for which a stated rate was to be charged; the inspection, at least once a year, of each mining county in the State; and the examination of as many of the mines and mining districts as was practicable. The salary of the State geologist was fixed at $1,200 a year, and, in addition, he was to be paid the amount of his actual traveling expenses while in the performance of his duties.

At its session in 1891 the legislature appropriated $50,000 for a geologic and mineralogical survey of the State, with maps and reports. In addition, an appropriation was made for the salary of the State geologist and for his traveling expenses. Soon after the adjournment of the legislature the supreme court set aside the appropriation of $50,000, so that none of it was spent.

The State geologist from 1890 to 1893 was George A. Bethune. He issued two annual reports, which were in the main descriptive of the mining districts, the building stones, clays, coal, and other phases of the economic geology of the State

The legislature at its session in 1893 made no provision for geologic work of any kind, and the office of State geologist became vacant and was not again filled until 1901, when a new law was enacted and all the older laws relating to this subject were repealed.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled State Geological Survey of the State of Washington; it was organized June 5, 1901.

SUMMARY OF LAWS.

The law establishing the Survey is as follows:

SECTION 1. There is hereby established a State Geological Survey of the State of Washington, which shall be under the direction of the board of geological survey of the State of Washington, which is hereby established, composed of the governor, the lieutenant governor, the State treasurer, the president of the University of Washington, and the president of the Washington Agricultural College and School of Science, who shall serve without compensation, but shall be reimbursed for actual expenses incurred in the performance of their official duties, and the said board shall have general charge of the survey, and shall appoint as superintendent of the Survey a geologist of established reputation, to be known as the State geologist, and upon his nomination such assistants and employees as the said board may deem necessary, and the said board shall also determine the compensation of all persons employed by the Survey, and may remove them at will.

SEC. 2. The said Survey shall have for its object:

1. An examination of the economic products of the State, viz, the gold, silver, copper, lead, and iron ores, as well as building stones, clays, coal, and all mineral substances of value.

2. An examination and classification of the soils and the study of their adaptability to particular crops.

3. The investigation and report upon water supplies, artesian wells, the water power of the State, gaging the streams, etc., with reference to their application for irrigation and other purposes.

4. An examination and report upon the occurrence of different road-building material.

5. An examination of the physical features of the State with reference to their practical bearing upon the occupations of the people.

6. The preparation of special geological and economic maps to illustrate the resources of the State.

7. The preparation of special reports with necessary illustrations and maps, which shall embrace both the general and detailed description of the geology and natural resources of the State.

8. The consideration of such other kindred scientific and economic questions as in the judgment of the board shall be deemed of value to the people of the State.

SEC. 3. The board shall cause to be prepared a report to the legislature before each regular meeting of the same, showing the progress and condition of the Survey, together with such other information as they may deem necessary and useful or as the legislature may require.

SEC. 4. The regular and special reports of the Survey, with proper illustrations and maps, shall be printed as the board may direct, and the reports shall be distributed or sold by the said board as the interests of the State and of science demand; and all money obtained by the sale of the reports shall be paid into the State treasury.

SEC. 5. All materials collected, after having served the purpose of the Survey, shall be distributed by the board to the University of Washington, the Washington Agricultural College and School of Science, the normal schools, and the leading high schools of the State in such a manner as to be of the greatest advantage to the educational interests of the State.

SEC. 6. The board of geological survey shall meet for organization within 30 days after the passage of this act. The regular meetings of the board shall be held on the first Wednesday in April and the first Wednesday in November of each year.

SEC. 7. The sum of $5.000 annually, or so much thereof as may be necessary, is hereby appropriated out of any funds in the treasury not otherwise appropriated, for the purpose of carrying out the provisions of this act.

SEC. 8. "An act to create a mining bureau and to define its powers and duties, and declaring an emergency," approved February 25, 1890; also "An act to create the office of a State geologist, prescribing his duties and compensation, and making an appropriation for the same, and declaring an emergency," approved February 28, 1890, are hereby repealed.

ORGANIZATION.

The governing board is described in section 1 of the foregoing law.

The executive officer of the Survey is known as the State geologist. He is appointed by the board of geological survey. His tenure of office is at the pleasure of the board. The present State geologist is Henry Landes, who was appointed June 5, 1901. The compensation of the State geologist has been fixed by the board at $5 a day, the number of days per annum not to exceed 100. This arrangement was made because the State geologist is also professor of geology in the University of Washington, from which he receives an annual salary. His service as State geologist is supposed to cover only the vacation months of the university.

The subordinates on the Survey are appointed by the board of geological survey, on recommendation of the State geologist. In practice this amounts to the board accepting the recommendations for the positions of chiefs of parties, leaving the State geologist free in his appointments to the minor positions. The clerical work is performed by a stenographer, who is paid by the hour and is employed for one-fourth to one-half of the time. The geologists and other assistants are mainly from the educational institutions of the State where there are departments of geology employing one or more men. Most of the minor positions are filled by advanced students from the departments of geology at the State institutions. The chiefs of parties and principal subordinates in the topographic and water resources work are employees of the United States Geological Survey. In cooperative work the minor employees are usually from the educational institutions of the State.

APPROPRIATIONS.

Appropriations for the support of the Survey are made by the legislature at its biennial session. The appropriation made at the last session of the legislature, in 1909, was in part contingent on cooperation with the United States Geological Survey. Unexpended balances lapse to the State treasury at the end of the biennium.

The biennial appropriation made at the session of the legislature in 1909 provided $55,000 for the work of the Survey. Of this sum $30,000 was for cooperation with the United States Geological Survey in topographic and water resources surveys, conditioned upon an equal sum being spent in the State by the Federal Survey; $20,000 was for geologic work, the details of which were not specifically set forth in the bill; and the remaining $5,000 was for the purpose of making a report upon the road-building materials of the State. The money has been expended in about the following proportions:

	Per cent.
Administrative and routine clerical work	4
Topographic surveys	35
Economic geology	27
Stream flow, etc	17½
Road materials	9
Soil surveys	7½

PUBLICATIONS.

The publications of the Survey consist of a series of bulletins, each one of which is devoted to a particular subject. The size of the edition varies from 1,200 to 2,500. A certain number of each edition are given away as exchanges and to public libraries, but the larger portion are sold at the actual cost of printing. Money received from the sale of reports must be paid to the State treasurer.

The appropriation for printing comes out of the Survey fund.

The board of geological survey, and through it the State geologist, has entire control of the printing of maps and reports so far as style of report, paper, illustrations, contents, etc., are concerned. The law provides, however, that the work must be done by the State printer, whose charges are regulated.

The State law provides that the State librarian shall be the custodian of all State reports. In the matter of Survey publications the State librarian may either distribute the reports from lists furnished by the State geologist or turn the reports over to the State geologist for distribution.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

Field work is now in progress on the cement materials of the State, and within a few months a report of the results will be published. Reports on several of the metalliferous mining districts and on the road-building materials of the State are also in course of preparation.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—As provided by the legislature at its last session, $30,000 of the Survey's appropriation is dependent on cooperation with the United States Geological Survey. At present $15,000 is spent annually by each organization, the money being divided on the basis of two-thirds for topography and one-third for water resources.

A detailed investigation and report on the coal fields of the State is being made in cooperation with the United States Geological Survey, the cost of collecting samples being borne by the United States Survey and the expense of the chemical analyses being borne by the State Survey. Under this agreement about 225 samples have been taken from coal beds in the working mines of the State and analyses made of the chemical properties of the coal.

United States Department of Agriculture.—Cooperation is carried on with the Bureau of Soils of the United States Department of Agriculture, in an economic soil survey of the logged-off lands of the western part of the State. The Federal Bureau supplies about half of the field force and does all of the office work and the printing. The amount of money expended by the State on this soil survey is about $2,000 a year.

WEST VIRGINIA.

PRESENT SURVEY.

The present State Geological and Economic Survey is the first one established in the State of West Virginia. Aside from the preparation, by Fontaine and Maury, of a "Centennial" volume on West Virginia's resources, in 1876, no official publication concerning the geology of the State had been issued since the annual reports (1835 to 1841) of the late Dr. Wm. B. Rogers, then State geologist, to the legislature of Virginia (which then included West Virginia), showing the progress made by the first Geological Survey of Virginia.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is the West Virginia Geological and Economic Survey; it was organized under law of February 26, 1897, amended in 1903.

HISTORICAL SKETCH.

The commission authorized by the act of February 26, 1897, met in December, 1897, and after its organization elected Dr. I. C. White as superintendent of the Survey, with the title of State geologist. Dr. White, from choice, has served the State without salary since 1901. James H. Stewart, director of the West Virginia Agricultural Experiment Station, was elected executive officer, and he has ever since continued to serve in that capacity, without compensation.

With the meager fund at his disposal ($3,000 annually) the State geologist had true meridians properly established and marked in every county of the State, as required by the act, and he also had prepared and published a State map, for the first time showing, by separate colors, the distribution of the several coal series as well as the developed oil and gas pools. In addition, volume 1 (on petroleum and natural gas) of the general series of State reports was prepared and published by the Survey, along with Bulletin 1 (entitled "Bibliography and cartography"). The cost of preparing and publishing the map, volume, and bulletin, having to be paid out of the Survey appropriations, consumed the remaining funds, and as the legislature failed to make any appropriations at its next biennial session, in 1899, geologic work was suspended during 1899 and 1900.

At the next session of the legislature, however, in 1901, biennial appropriations were resumed, and they have been made regularly ever since. A new department of work was inaugurated in 1901—the making of a new topographic map of the State, on a scale of 1:62,500, in cooperation with the United States Geological Survey. The State appropriations for this work have been approximately $15,000 a year. The appropriations for purely geologic and economic work have grown from year to year with the needs of the Survey, as will be seen from the table given under "Appropriations."

SUMMARY OF LAWS.

The present Survey of West Virginia had its origin in an act of the legislature passed February 26, 1897, which reads as follows:

An act to establish a State Geological and Economic Survey and to make provision for the preparation and publication of reports and maps to illustrate the natural resources of the State, together with the necessary investigations preparatory thereto.

[Passed February 26, 1897. In effect from passage. Approved February 26, 1897.]

Be it enacted by the Legislature of West Virginia:

1. That there is hereby established a State Geological and Economic Survey, which shall be under the direction of a commission composed of the governor, the treasurer, the president of the West Virginia University, the president of the State Board of Agriculture, and the director of the West Virginia Agricul-

tural Experiment Station, who shall serve without compensation but shall be reimbursed for actual expenses incurred in the performance of their official duties; and the said commissioners shall have general charge of the Survey, and shall appoint as superintendent of the same a geologist of established reputation, and such assistants and employees as they may deem necessary; and they shall also determine the compensation of all persons employed by the Survey, and may remove them at pleasure.

2. That the Survey shall have for its objects:

First, an examination of the geological formations of the State with especial reference to their economic products, namely, building stones and other constructive minerals and resources; clays, ores, and other mineral substances and fuels, the prevention of their waste, and the utilization of by-products.

Second, an examination and classification of the soils and a study of their adaptability to particular crops.

Third, an examination of the forests and timber lands of the State with reference to the economic utilization of the same and the prevention of their waste.

Fourth, an examination of the physical features of the State with reference to their practical bearing upon the occupations of the people, the industrial development, and the material prosperity of the several sections of the State, having due regard to their varying resources, conditions, and needs.

Fifth, the preparation of special geological and economic maps to illustrate the resources of the State.

Sixth, the preparation of special reports, with necessary illustrations and maps, which shall embrace both a general and detailed description of the geology and natural resources of the State.

Seventh, the consideration of such other scientific and economic questions as in the judgment of the commissioners shall be deemed of value to the people of the State, and the immediate establishing and the proper marking of the true meridian points in the several county seats of the State.

3. That the commissioners shall cause to be prepared a report to the legislature before each meeting of the same, showing the progress and condition of the Survey, together with such other information as they may deem necessary and useful or as the legislature may require.

4. That the regular and special reports of the Survey, with proper illustrations and maps, shall be printed as the commissioners may direct, and that the reports shall be distributed or sold by the said commissioners as the interests of the State, the diffusion of practical information relating to the development of the State, and the advancement of science may demand; and all moneys obtained by the sale of the reports shall be paid into the State treasury.

5. That all materials collected, after having served the purpose of the Survey, shall be distributed by the commissioners to the educational institutions in such manner as to be of the greatest advantage to the educational interests of the State; or if deemed advisable the whole or part of such material shall be put on permanent exhibition.

6. That the sum of $3,000 annually, for the years 1897 and 1898, or so much thereof as may be necessary, is hereby appropriated, out of any funds of the treasury not otherwise appropriated, for the purpose of carrying out the provisions of this act.

Sections 4 and 6 of this act, relating to the disposal of the fund received from the sales of publications, etc., were amended in 1903 so as to read as follows:

SEC. 4. That the regular and special reports of the Survey, with proper illustrations and maps, shall be printed as the commission may direct, and the

reports shall be distributed or sold by the said commission as the interest of the State, the diffusion of practical information relating to the development of the State, and the advancement of science may demand; and all moneys obtained by the sales of the reports may be used to defray the cost of publication and their distribution to the people, and any balance remaining shall be paid into the treasury.

SEC. 6. That the engineers, surveyors, and other persons employed by and acting for said Survey, and all such persons employed by and acting for the United States Geological Survey, or other department of the United States Government, having for their object the obtainment and diffusion of practical information relating to the resources and development of the State, and the advancement of science, and for the purpose of carrying out the objects of said State Geological and Economic Survey, shall have the right to enter upon all lands, either public or private, and enter all mines, for the purpose of exploring, surveying, or doing any other matter or thing which may be necessary to effect the said objects, and examine any property, products, or developments relating to the objects of said Survey, within the State, without molestation or arrest and without being liable to the owners thereof, except for actual damages done to the property.

ORGANIZATION.

The form of organization of the Survey is described under "Summary of laws."

The governing body is the commission, composed of the governor, the State treasurer, the president of the West Virginia University, the president of the State Board of Agriculture, and the director of the West Virginia Agricultural Experiment Station.

The State geologist and the executive officer of the Survey are appointed by the commission. The present State geologist is Dr. I. C. White, who has served since the organization of the Survey in 1897; since 1901 he has served without compensation. The present executive officer is James H. Stewart, who is also director of the West Virginia Agricultural Experiment Station; he serves without compensation from the Survey. The other active employees of the Survey and their annual salaries are as follows:

Chief clerk	$1,500
Stenographer and assistant clerk	1,200
Forester (temporary)	1,800
Assistant geologist	2,400
Assistant geologist	2,000
Chief chemist (duties largely supervisory)	600
Assistant chemist	1,500

Employees are appointed and their rates of compensation are fixed by the commission, on recommendation of the State geologist. The latter has authority to suspend any of the minor employees for cause.

No college professors are employed, but the chief chemist and his assistant also serve the State Agricultural Experiment Station in

the same capacity, and the Survey analyses are made in the Experiment Station laboratory, the Survey paying only the cost of chemicals, etc., consumed in its work.

The office of the Survey is in the library of the State University at Morgantown, the university having generously offered accommodations free of charge at the beginning of the Survey's existence. As the chemical laboratory of the West Virginia Agricultural Experiment Station, where all the chemical work of the Survey is done, is under the control of the university regents, the State is not only saved the expense of providing office accommodations for the Survey, but also the cost of duplicating the facilities for chemical work.

APPROPRIATIONS.

Appropriations are made biennially, and unexpended balances do not lapse into the State treasury if unused at end of fiscal year (September 30).

The cost of administration from the beginning of the Survey to July, 1910, has been $7,222.36.

A summary of the appropriations is given below.

Legislative appropriations made to the West Virginia Geological Survey from 1897 to and including 1910.

Year.	General purposes.	Cooperative topographic surveys.	Salaries for the geologic staff.	Preparation and publication of reports.	Field and other expenditures.
1897	$3,000				
1898	3,000				
1899					
1900					
1901		$10,000		$5,000	
1902		20,000		2,500	
1903		15,000		5,500	$2,000
1904		15,000		2,000	2,000
1905		15,000	$5,000	5,000	2,000
1906		15,000	5,000	5,000	2,000
1907		15,000	5,000	5,000	2,000
1908		15,000	5,000	5,000	2,000
1909		12,000	10,400	5,000	2,500
1910		12,000	10,400	10,000	2,500
1911		12,000	10,400	5,000	2,500
1912		12,000	10,400	5,000	2,500
	6,000	168,000	61,600	60,000	22,000

The total appropriations from 1897 to and including 1912 have amounted to $317,600.

PUBLICATIONS.

The publications of the Survey began in 1899 and include (1) a series of volumes devoted to the economic geology of the State, (2) a series of detailed county reports, (3) a series of bulletins on special subjects, and (4) a series of geologic and economic maps. Of the

economic volumes seven have been issued, two devoted to petroleum and natural gas, two to coal, one to iron ores, building stones, and other minerals, one to clays, limestones, and cements, and one to forestry and wood industries. Of the county reports three have been issued, covering Ohio, Brooke, Hancock, Marshall, Wetzel, Tyler, Pleasants, Wood, and Ritchie counties. Of the bulletins two have been issued, one being a bibliography of all known publications (books and maps) on the State, and the other being devoted to levels and coal analyses. Of the maps, four editions of an economic map showing the coal, oil, gas, and limestone areas of the State have been issued, a total of 17,000 copies, and one edition (5,000 copies) of a map showing railroads and county products.

The editions of the economic volumes have varied from 2,000 to 7,000 copies. Of the county reports the editions have been 2,500 copies. Of Bulletin 1 the edition was 1,500 copies, and of Bulletin 2 3,500 copies.

The cost of all printing and engraving is paid out of Survey appropriations, and all matters pertaining to the printing are under the control of the commission and the State geologist. The cost of printing has varied as follows: Economic volumes, from $676 to $3,778; detailed county reports, from $2,412 to $3,369; economic maps, from $300 to $778; Bulletin 1, $149; Bulletin 2, $1,534.

The distribution of publications is under the control of the State geologist. Copies are sent to all State officials, and exchanges are made with all State and National surveys and with some distinguished geologists. Those who have given the Survey conspicuous aid are furnished with complimentary copies of all publications desired. To all others the publications are sold at moderate prices. Libraries and teachers are given a discount of 40 per cent from the regular price list, and a large discount is also made to persons who purchase all or several of the Survey publications.

The demand for the publications is constant, and from October 1, 1901, to March 25, 1911, the receipts from their sales, which revert to the Survey, amounted to $10,209.64.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

Of the series of general reports on the economic resources of the State, six volumes have already been published, as described under "Publications." A volume on the forests and plant life of the State is nearly completed, and other volumes of a general nature are planned.

Of the series of county reports, three have been issued and two others are in preparation. For these reports two or three counties are

grouped together, and the quadrangle base maps are compiled into a single map of the entire area, which is published in three forms—one showing the topography, one showing the geology, and one showing the soils. The soil maps are prepared in cooperation with the United States Bureau of Soils.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—In cooperation with the Federal Survey, topographic mapping of the State, on a scale of 1:62,500, with 20-foot and 50-foot contours, is being prosecuted each season.

United States Bureau of Soils.—In cooperation with the Bureau of Soils of the United States Department of Agriculture a soil survey of each county is being made, the resulting soil maps being published in connection with the series of county reports. Up to the present time soil maps of nine counties have been published and eight other soil maps are in course of preparation.

WISCONSIN.

PREVIOUS SURVEYS.

The earliest geologic surveys in Wisconsin were made under the authority of the United States Government by D. D. Owen. In 1839 and 1840 he surveyed the Mineral Point district, and in 1847 the northwestern part of Wisconsin and the adjacent portions of Minnesota and Iowa.

In 1853 Edward Daniels was appointed State geologist of Wisconsin, but in 1854 he was succeeded by James G. Percival, who held office until his death, May 2, 1856. Each of these men made a brief report, chiefly on the southwestern portion of the State.

A general geologic survey of the State was not commenced until 1873, when a survey was ordered by the legislature and I. A. Lapham was appointed State geologist. He continued in that position for two years, when he was succeeded by O. W. Wight, who held the position one year. Lapham died in 1876. In February of that year Dr. T. C. Chamberlin was placed in charge of the survey, and he carried it through to completion. No publications were issued until after Chamberlin's appointment. Among the members of his staff were R. D. Irving, Moses Strong, E. T. Sweet, T. B. Brooks, and I. C. Wooster. The paleontology was in charge of R. P. Whitfield and the natural history in charge of F. H. King. The field work of the survey was completed in 1879. The report appeared in four octavo volumes, containing about 3,035 pages, with an atlas containing 45 maps. The last volume was published in 1883.

Under the direction of Dr. Chamberlin the geologic survey of the State was made as thorough and complete as possible under the con-

ditions then existing. It was necessarily much less detailed in the northern part of the State, then largely forest, than in the southern part, but even in the unsettled regions the general problems of the geology were worked out with great accuracy. Few State surveys have more clearly conceived the nature and scope of the general problems of a survey, and still fewer have executed their plans more completely and satisfactorily.

After the publication of this report the organization ceased to exist, and no geologic work was done by the State until 1897. One reason for this is to be found in the exceptional completeness of the Chamberlin survey. If the work had been continued it would necessarily have been along new lines, such as the investigation of special geologic problems and subjects of economic importance. It may also be noted that most of the geologists of the State were at that time becoming engaged in work for the United States Geological Survey, then in process of rapid development. This fact was not without influence in turning them away from local problems to those of a broader nature and concerning larger areas than the State.

The present Survey, therefore, is not a continuance or a direct outgrowth of any preceding organization. It was established partly to complete the general survey of the northern part of the State, partly to investigate special geologic questions of economic or scientific importance, and partly to extend the survey along new lines of study which have been opened in later years.

PRESENT SURVEY.

LEGAL DESIGNATION AND DATE OF ORGANIZATION.

The present organization is entitled the Wisconsin Geological and Natural History Survey; it was organized in 1897.

SUMMARY OF LAWS.

The law creating the present Survey was passed in the spring of 1897. It provided for (1) the completion of a geologic survey of the State with special reference to economic features; (2) a study of the soils of the State; (3) a study of the plants, especially of the forests, with reference to cultivation and preservation; (4) a study of the animal life of the State, especially the fish; (5) a study of the physical geography and natural history of the State and the publication of results in such form as to serve as manuals for the public schools; and (6) the completion of a topographic map of the State.

ORGANIZATION.

Governing board.—The governing board of the Wisconsin Geological and Natural History Survey is an ex officio body, composed of the governor of the State, the president of the State University,

the State superintendent of public instruction, the president of the State Fish Commission, and the president of the Wisconsin Academy of Sciences, Arts, and Letters. The State superintendent of public instruction is elected to his office by the people; the president of the State Fish Commission is elected by the members of the commission, who, in turn, are appointed by the governor. The term of office of the members of the board is dependent on their occupancy of the positions, by virtue of which they become members of the board. They receive no compensation except their actual traveling expenses while attending meetings, which are ordinarily held from two to four times a year.

Executive officer.—The executive officer is called superintendent and director. The present incumbent is Dr. E. A. Birge, who was appointed by the board in 1897 for an indefinite term. The director is dean of the college of letters and science of the University of Wisconsin, and devotes approximately 20 per cent of the year to the work of the Survey. His salary is $500 a year; it is fixed by the governing board.

Clerical force.—The clerical force consists of one clerk, who is employed for only a part of the time.

Geologic division.—The geologic division consists of the State geologist, W. O. Hotchkiss, and two other geologists on the permanent staff, all of whom give their full time to the Survey and are not connected with the university in any way. In addition to these permanent employees, the summer field parties are usually made up from advanced students in the University of Wisconsin, who are placed in charge of one of the permanent employees. Members of the geology department of the university staff are frequently employed for working out particular problems, and at the present time four members of the department have such work for the Survey under way or in contemplation.

Water-power division.—The water-power division has done comparatively little work for two years. Prof. Leonard S. Smith, of the college of engineering of the University of Wisconsin, is in charge of this work.

Highway division.—The highway division consists of the State geologist, who is chief of the division, two highway engineers, two bridge engineers, and one clerk. All these men give their full time to the Survey.

Natural-history division.—The natural-history division is in immediate charge of the director, who gives a large part of his summer vacations to the work of this division. The Survey employs one man who gives a small amount of his time to the university, and a

member of the biology department of the university gives a portion of his time to the work of the Survey. Advanced students in chemistry and biology in the university are employed for summer field work.

Soil division.—The division of soils is in immediate charge of Prof. A. R. Whitson, of the college of agriculture of the University of Wisconsin. Most of the work is done in cooperation with the United States Department of Agriculture and the University of Wisconsin. One chemist and one assistant give full time to this division and numerous other persons give part of their time, chiefly as field assistants and chemists.

Method of appointment and compensation of assistants.—The scientific assistants employed in the divisions of the Survey are nominated by the chiefs of the divisions, subject to approval by the director, and appointed by the board. The clerks are subject to the civil-service law of the State.

There is no specified term of service in any department of the Survey. The special work of the divisions is usually paid for at a per diem rate or at a contract rate for the piece of work specified. Permanent employees of the geologic division are paid from $75 to $250 a month. Temporary assistants employed during the summer field season comprise both students, who are taken out for the payment of their expenses only, and experienced men, who are paid $100 a month.

In the highway division assistant engineers receive from $50 to $200 a month. In the natural-history division the assistants are paid from $30 to $125 a month, and in the division of soils from $30 to $100 a month.

APPROPRIATIONS.

An appropriation of $5,000 annually for two years was made by the act of 1897 creating the Survey. In 1899 the appropriation was increased to $10,000 annually for the succeeding two years. In 1901 the appropriation was reduced to $5,000 annually and was made a continuing appropriation. In 1903 the annual appropriation was increased to $10,000, and it has remained at that figure ever since.

In 1905 a special appropriation of $2,500 was granted for the purpose of making a survey of the water powers of the State. In 1907 an additional special appropriation of $10.000 annually for two years was made for the purpose of carrying on investigations with regard to road building in the State, extending the survey of the lead and zinc district of Wisconsin, and continuing the water-power survey. In 1909 the special appropriation of $10,000 was continued for two more years, and a second special appropriation of $10,000 annually

for two years was made for the prosecution of the soil survey of the State.

Unexpended balances carry to the new year.

The present distribution of the appropriations is about as follows:

	Per cent.
Administration	2
Geology (average four years)	22
Natural history (average four years)	8
Roads (average three years)	26
Soils (one year)	28
Publications (average five years)	14

The Survey has done no topographic work except in connection with the geology of parts of the lead and zinc district, where careful surveys of about 272 square miles were made with 10-foot contours.

The cost of administration is hardly more than nominal. The director of the Survey is also a member of the State university. He spends his vacations in work for the natural-history division of the Survey, and during the year carries on the executive work of the Survey along with that of the university, with the assistance of one clerk for a part of the time. The director receives practically no compensation for the executive work, and the expenses of administration, therefore, can not be regarded as normal for a Survey having this income. Offices and laboratories for all departments are furnished by the University of Wisconsin. Thus almost the entire income of the Survey is devoted to scientific and economic work.

PUBLICATIONS.

The publications of the Survey are issued as biennial administrative reports, bulletins, and maps. The bulletins are divided into an economic series, of which 13 have been issued; an educational series, of which 2 have been issued; a scientific series, of which 6 have been issued; and road pamphlets, of which 5 have been issued. The maps include 10 hydrographic maps of lakes and lake districts, and a general geologic and road map of the State, which is in press.

The editions vary from 1,200 to 3,000 for the scientific and educational series, 2,500 to 5,000 for the economic series, and 40,000 for the road pamphlets. Publications are distributed for the approximate cost of mailing, until the edition becomes nearly exhausted, when a price is put on the volumes. The average annual income from this source is small. It goes into the State treasury.

The average annual cost of printing reports and accompanying maps for the last five years has been approximately $5,000. This is paid out of the State printing fund.

The printing of reports must be done, according to law, by the State printer, but the choice of paper, the style of report, binding, etc., are left to the Survey. The engraving of maps and illustrations is let to engravers acceptable to the Survey. There is no statutory limitation as to the contents or number of any report.

According to law, a certain number of copies of each report must be sent to each member of the legislature, to several State officers, and to the library of the State Historical Society. Otherwise the distribution of reports is entirely in the hands of the Survey. Its mailing list, which includes numerous universities and scientific societies throughout the world, is kept alive by revision at irregular periods, as the need arises. Exchanges are carried on in cooperation with the University of Wisconsin and the Wisconsin Academy of Sciences, Arts, and Letters.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

The present main lines of work carried on independently by the Survey consist of (1) an areal survey of the northwestern portion of the State; (2) a geologic survey of the iron district in Florence County; (3) a survey of the peat resources of the State; (4) a new geologic and road map of the State, on the scale of 6 miles to the inch; (5) a survey of the Lake Superior shore, to determine the origin and proper correlation of the Lake Superior sandstone; (6) the work of the highway division, which consists in furnishing technical advice and assistance to town and county officers having charge of road and bridge building; (7) the compilation of a report on the general geology of the State as an educational bulletin for use in schools; (8) the preparation of an educational bulletin on the relation of the physiography and the industries of the State; and (9) the continuance of the survey of the lead and zinc district of southwestern Wisconsin.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—Informal cooperation with the United States Geological Survey has been maintained in the survey of the lead and zinc district. The survey of the water powers of the State has also been carried on in conjunction with the United States Geological Survey, each organization paying half of the field expenses.

United States Bureau of Fisheries.—The United States Bureau of Fisheries and the State Fish Commission have cooperated to a small extent in a survey of the lakes of Wisconsin, chiefly carried on by the

State Survey, and in collecting materials for a report on the fishes of the State.

United States Bureau of Soils.—The soil survey begun in 1909 is carried on in conjunction with the Bureau of Soils of the United States Department of Agriculture and the college of agriculture of the University of Wisconsin. The United States Bureau of Soils places as many men in the field as the State Survey, shares the expense of field parties, and contributes much office and laboratory work. The college of agriculture of the University of Wisconsin provides supervision for the survey and quarters for the laboratory work.

APPENDIX.

INTERNAL IMPROVEMENT COMMISSION OF ILLINOIS.

ORIGIN.

The Internal Improvement Commission of Illinois, as it is officially designated, was created by act of the forty-fourth general assembly of Illinois, approved May 16, 1905, and in force July 1, 1905, with a tenure of two years. This act was the outgrowth of a popular movement favoring the construction of a deep waterway from Lake Michigan to the Gulf of Mexico, and the development of the collateral utilities of such canalization of the Illinois River within the State. There was no antecedent bureau of the State exercising exactly the functions contemplated in this act, though the topographic work of the State Geological Survey embraced some of them in a measure. The Commission was organized February 20, 1906. The original act provided for an existence of only two years, but the forty-fifth general assembly, under an act approved December 24, 1907, extended the life of the Commission four years.

SUMMARY OF LAWS.

The scope of the work of the Commission is outlined as follows in the act of May 16, 1905:

The duties of this Commission shall be to investigate the various problems associated with a projected deep waterway from Lake Michigan to the Gulf of Mexico, and the reclamation of lands subject to overflow or inundation, the construction of practical and substantial levees, the ascertaining of the acreage of lands now subject to inundations from rivers, the increase from benefits to be derived from this proposed deep waterway and reclamation of lands subject to overflow or inundation, and such other statistics and data.

The following act was approved May 17, 1907:

An act making an appropriation to the Internal Improvement Commission of Illinois, for the purpose of repairing and strengthening the levee at Shawneetown, Ill.

SECTION 1. Be it enacted by the people of the State of Illinois, represented in the general assembly, That there is hereby appropriated to the Internal Improvement Commission of Illinois, the sum of $17,000. for use in repairing and strengthening the levee at Shawneetown, Ill., so as to protect said city from floods and overflows of the Ohio and Wabash rivers.

SEC. 2. The auditor of public accounts is hereby authorized and directed to draw his warrant from time to time upon the State treasurer for the moneys herein appropriated upon proper vouchers, certified by the said Commission and approved by the governor.

ORGANIZATION.

The governing body is the board of commissioners, composed of three members (Isham Randolph, H. W. Johnson, and T. K. Condit), appointed by the governor. The term of office is indefinite. The members receive no compensation for their services, but are reimbursed for traveling expenses.

The executive officer is the secretary, who is appointed by the commissioners. The present incumbent is Robert Isham Randolph, who was appointed January 1, 1908. The term of office of the secretary is indefinite. He devotes his entire time to the work of the Commission, and is paid an annual salary of $3,600. The amount of the salary is fixed by the commissioners.

The assistants employed and their compensations are as follows: Stenographer, $50 a month; office boy, $5 a week; one junior engineer, $100 a month; one field assistant, $75 a month; 23 gage readers, $3 a month; one draftsman, $125 a month.

APPROPRIATIONS.

Appropriations are made biennially. None are contingent upon cooperation, but a large proportion of the funds are applied in cooperation. The amount of the appropriation varies; for the current biennium it is $30,000, no particular objects being specified.

Unexpended balances lapse to the treasury three months after the close of the fiscal year.

Disbursements are about as follows:

Administration	$4,000
Drainage surveys	5,000
Measurements of stream flow	5,000
Waterway promotion work	1,000

PUBLICATIONS.

Two reports of the Commission have been issued, one in February, 1907, entitled "The Lakes and Gulf waterway," and one in March, 1909, entitled "The Illinois waterway report, with plans and estimates of costs for a waterway from Lockport, Ill., to Utica, Ill., by way of the Des Plaines and Illinois rivers." The edition of each was 5,000 copies. The reports are submitted to the governor, who has them printed. The cost of printing is paid from the governor's appropriation, and the Commission has no control over the printing.

The reports are distributed free. The mailing list is made up of engineering societies, boards of trade, and civic organizations.

PRESENT LINES OF WORK.

INDEPENDENT INVESTIGATIONS.

Independently of the Federal Government, and as a part of the so-called internal improvement plan, the Commission is developing the navigable waterways of the State.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—In cooperation with the United States Geological Survey, 23 gaging stations are maintained for measuring the flow of streams.

Illinois State Geological Survey.—In cooperation with the State Geological Survey, engineering studies are being made of the navigability of Kaskaskia and Big Muddy rivers and drainage of bordering lands. The topographic maps required are prepared by the State Geological Survey in cooperation with the United States Geological Survey.

United States Department of Agriculture.—In cooperation with the United States Department of Agriculture, engineering studies are being made looking to the drainage of swamp and overflowed lands along Little Wabash and Skillet Fork rivers.

TERRITORIAL ENGINEER OF NEW MEXICO.

The office of Territorial engineer of the Territory of New Mexico was created by the legislature of 1907. The laws governing the office provide for the general supervision of the waters of the Territory and all matters pertaining to irrigation, the making of hydrographic and topographic surveys of stream systems with reference to the adjudication of water rights, the appropriation of water rights for beneficial uses, and the supervision of the construction of all county bridges costing more than $1,000.

ORGANIZATION.

There is no governing board. The executive officer is the Territorial engineer, who is appointed by the governor for a term of four years, at a salary of $2,400 a year. He is also permitted to receive not more than $2,000 a year for his services as consulting engineer on irrigation projects. The present incumbent is Vernon L. Sullivan, who was appointed in April, 1909.

The Territorial engineer is also a member of the good roads commission, and supervises the work of that commission, and is a mem-

ber of the Carey Act land board, and serves as engineer in the construction of the projects of that board. The good roads commission and the Carey Act land board are composed of the governor as chairman, the land commissioner as secretary, and the Territorial engineer as engineer. The members of these organizations receive no compensation for their services.

The assistants to the Territorial engineer include five assistant engineers and two clerks. The engineers are college men and do not come under the civil-service rules.

APPROPRIATIONS.

The annual appropriation for the office of the Territorial engineer is $8,000; for hydrographic work, $3,000; for good-roads construction, $50,000. Balances carry to the new fiscal year.

The annual appropriation for the office of the Territorial engineer includes maintenance and salaries of officers not chargeable to specific appropriations. The appropriation of $3,500 is for maintenance of gaging stations and payment of salaries of men connected with stream gaging. For the topographic and hydrographic surveys connected with the adjudication of water rights a fee is charged by the Territorial engineer. This is placed in a special fund, which thus becomes cumulative.

PUBLICATIONS.

The publications comprise the biennial report for 1907–8 and a bulletin on the economical use of water for irrigation. The results of the cooperative work with the United States Geological Survey are published by the Federal bureau in its series of water-supply papers. The biennial report for 1909–10 and a report on road construction will soon be issued by the Territorial engineer. The size of edition depends on the nature of the report. The publications are sent generally to those who apply for them.

The cost of printing the biennial reports is $300 annually, which is paid from the general appropriation of the Territorial engineer. The cost of printing specific reports is $200; this is paid from the specific fund.

The Territorial engineer has full control over the printing of reports and maps, being limited only in appropriations. He also has full control over the distribution of reports.

COOPERATIVE INVESTIGATIONS.

United States Geological Survey.—In cooperation with the United States Geological Survey 41 gaging stations are maintained on streams in the Territory. The results are published by the Federal Survey.

Good roads commission.—The Territorial engineer is also engineer and supervisor of the work of the good roads commission. It is customary for the counties through which a road is to be built to pay half of the cost of construction. Corporations, towns, and interested persons also contribute to the cost of road building. In this work convict labor is employed as much as possible.

NEW YORK STATE WATER SUPPLY COMMISSION.

PREVIOUS COMMISSIONS.

The New York State Water Supply Commission, in its work relating to the control and supervision of the water resources of the State, was preceded by the Water Storage Commission of 1902 and the River Improvement Commission of 1904, while some of the work now intrusted to it was previously under the supervision of the State engineer and surveyor and the State geologist.

New York State Water Storage Commission.—After a series of disastrous floods which occurred in the State during the years 1900 and 1901, in response to popular demand, the legislature of 1902 created the New York State Water Storage Commission, and charged it with the duty of investigating the floods and making recommendations regarding the possibility of eliminating the danger from floods by the construction of storage reservoirs. The Commission consisted of nine members, who served without compensation except actual expenses. Four of the number were ex officio members, the attorney general, the State engineer and surveyor, the superintendent of public works, and the forest, fish, and game commissioner. The other members were appointed by the governor and were citizens representing different sections of the State; three of them were civil engineers. This Commission spent a year in investigating the causes and damages of the floods, and in January, 1903, submitted a report, in two volumes, to the legislature. With the presentation of this report the duties of the Water Storage Commission were fulfilled and it was discharged.

River Improvement Commission.—The River Improvement Commission was created by chapter 734 of the laws of 1904, which became a law on May 14 of that year. This Commission was created "for the regulation of the flow of watercourses in this State in aid of the public health and safety." It was composed of five members, four ex officio "and one commissioner who shall be a civil engineer." The ex officio members were the attorney general, the State engineer and surveyor, the superintendent of public works, and the forest, fish, and game commissioner. The fifth member, the civil engineer commissioner, was appointed by the governor. All the members served without compensation, except the civil engineer commissioner, who re-

ceived a per diem compensation, fixed by his colleagues, for the actual time devoted to the work of the commission. All the commissioners received their necessary expenses in connection with the work. To this Commission was given the power—

to regulate watercourses, by deepening, widening, and straightening, or by the construction of dams, dikes, or storage reservoirs, but only upon petition praying for the improvement being duly made to it by the parties to be benefited. Any county, city, town, or village located upon any river or watercourse, or any person or persons having riparian rights thereon, may petition the Commission for the improvement of such river or watercourse, and the Commission is charged with the responsibility of determining whether the relief asked for is practicable and is of sufficient importance to the public health and safety to warrant the State in undertaking the work. The entire cost of such improvements must be borne by the counties, towns, cities, villages, and individuals benefited by the regulation of the flow of the stream, unless the Commission shall have determined and reported to the legislature that a portion of the expense is a just and proper charge upon the State. The proportion of the cost which each shall bear, including the State, is determined by the Commission and reported to the legislature, and no such improvement shall be undertaken until after such report has been submitted and the legislature shall have authorized the improvement to be made.

All of the work to be done by the River Improvement Commission was predicated upon the theory of the protection of the public health and safety. Several applications were made under this law, and the proposed improvements were being investigated, when in 1906 the duties and powers of the River Improvement Commission were transferred by law to the State Water Supply Commission.

PRESENT COMMISSION.

SUMMARY OF LAWS.

The New York State Water Supply Commission was created by chapter 723 of the laws of 1905, and was duly organized when the act became a law on June 3 of that year. The Commission is composed of five citizen members, who are appointed by the governor. The principal duty of the Commission as defined in the original act was the supervision over public water supplies. The law provides that no municipal corporation or other civil division of the State, no private water company, and no individual shall have the right to construct a public water-supply system or seek a new source of water supply which involves the acquisition of land until maps, plans, and profiles of the proposed work have been submitted to and approved by the State Water Supply Commission. The Commission was further charged with the duty of investigating all of the then existing water-supply systems in the State and reporting on the sources and purity of their supply, the present and future needs of the community, and the general features of operation of the systems. It was also charged

with the investigation of the disposal of sewage by municipalities, especially with reference to the possible contamination of present and future public water supplies.

Since the organization of the commission its duties have been enlarged by several amendments to the original act and by new enactments, until at the present time it has supervision over public water supplies for domestic uses, river improvement for the prevention of flood damage and the protection of the public health and safety, and the investigation of the water resources of the State, involving the building of storage reservoirs for the improvement of existing water-power developments and for the creation of new power developments under State ownership and control. The authority for the work last named was conferred by chapter 569 of the laws of 1907, known as the Fuller bill, wherein the State Water Supply Commission was directed " to devise plans for the progressive development of water powers of the State under State control and for the public use and benefit."

The laws under which the Commission is now conducting its operations are article 2, chapter 54, consolidated laws of 1909; chapter 569 of the laws of 1907; and chapters 284 and 464 of the laws of 1909. Article 2 of chapter 54 of the consolidated laws of 1909 is a consolidation of the various laws and amendments theretofore passed creating and governing the River Improvement Commission and the State Water Supply Commission.

ORGANIZATION.

The State Water Supply Commission consists of five members, appointed by the governor for a term of five years, except that the original commissioners were appointed, one for five years, one for four years, one for three years, one for two years, and one for one year. Their compensation is fixed by law at $5,000 per annum.

The executive officer is the president, Henry H. Persons, the five-year member of the original board, who devotes the greater portion of his time to Commission matters. The other officers of the Commission are a secretary and a consulting engineer, both of whom are appointed by the Commission, independently of the civil-service commission.

The secretary has charge of the routine administrative work of the office. He employs two stenographers, one clerk, and one office boy. The consulting engineer is the executive head of the engineering bureau, and his clerical force consists of two stenographers and one office assistant. The clerical force is appointed by the Commission from selections made from certified civil-service lists; the salaries of the clerical force are fixed by law.

The engineering assistants are appointed by the consulting engineer, from certified civil-service lists, all appointments being subject to approval by the Commission. The engineering field and office corps varies in size from time to time in accordance with the needs of the work. At present it consists of about 40 men, who receive the following rates of compensation: One division engineer, $275 a month; 2 assistant engineers, $200 a month; 4 assistant engineers, $5 to $6 a day; 4 levelers, $4.50 to $5 a day; 4 rodmen, $3.50 to $4 a day; 8 chainmen, $2.50 to $3 a day; 8 axmen, $2 a day; 2 tracers, $50 to $75 a month; laborers, guides, and camp cooks, as required, $2 to $2.50 a day.

In 1907 the engineering corps numbered about 50 men, in 1908 about 125 men, and in 1909 about 75 men. The principal work which has engaged the attention of the engineering corps has been the investigation of water storage and possible water-power sites on the principal rivers of the State, and surveys in connection with projects for river improvement.

During the summer months college students are frequently employed in the minor field positions, as many of them are enrolled on the civil-service lists, but college professors are not regularly employed. On several occasions, however, during the last three years, matters relating to the geologic classification of drill-boring samples and the stability of foundations for certain proposed storage-reservoir dams have been submitted to professors eminent in their lines, who have furnished reports on the special subjects submitted to them.

The salaries of the commissioners, the secretary, and the consulting engineer are paid monthly; all other salaries are paid semimonthly, as required by a recent act of the legislature.

APPROPRIATIONS.

Appropriations for conducting the work of the Commission are made annually. The salaries and expenses of the Commission, Secretary, consulting engineer, and the clerical force are provided for in the annual "appropriation bill," and are fixed by law. For the prosecution of investigations of water power and river improvement appropriations are made annually in the "supply bill." These appropriations are based on detailed estimates of the probable needs of the Commission, which are submitted to the legislature on or before January 1 of each year. The Commission is free to subdivide and allot the several appropriations in the supply bill as it may deem wise, provided the money is expended within the scope of the object specified in the supply bill. Unexpended balances, if any, carry over the first year, but are not available after the second year unless reappropriated by the legislature. The fiscal year of the State begins

October 1. Moneys appropriated in the appropriation bill are available on the 1st day of October next succeeding the passage of the bill, and are for the use of the Commission during the year succeeding. Appropriations made in the supply bill are available for use as soon as the bill becomes a law, and deficiencies of the previous year, if any exist, may be paid out of these moneys.

The appropriation for the year 1910–11 in the appropriation bill is $41,680, made up as follows:

Salaries of commissioners	$25,000
Salaries of secretary and consulting engineer	7,000
Salaries of clerical force	3,180
Traveling expenses of Commission	2,500
Traveling expenses of secretary and consulting engineer	500
Miscellaneous office expenses	3,500

The appropriations in the supply bill for 1910–11 amount to $70.000, as follows:

For water supply and river improvement investigations and operations	$20,000
For continuing water storage and water power investigations	50,000

Of the $20,000 appropriation the Commission has allotted $10,000 to the completion of surveys and studies in connection with projects for river improvement now in hand, and the remainder is held in reserve to meet the expenses of any applications for river improvement which may be presented during the current year and also for the study of drainage, underground waters, etc.

The $50,000 appropriation has been subdivided and allotted by the Commission as follows:

Stream gaging, rain gaging, and evaporation studies, in cooperation with the United States Geological Survey	$10,000
Maintenance of the Albany headquarters office of the engineering bureau	10,000
Power surveys and investigations on Hudson River	10,000
Power surveys and investigations on Black, Oswego, and other rivers and on Finger Lakes	15,000
Surveys and the collection of data in connection with irrigation and small water-power developments for farm uses and benefits	2,000
Reserved for contingencies	3,000

Between July 1, 1907, and July 1, 1910, the Commission expended $7,950 for stream gaging in cooperation with the United States Geological Survey, most of the sum being expended in the Adirondack Mountain region and on Genesee, Raquette, and Hudson Rivers. During the same period $1,055 was expended for rainfall and evaporation observations in cooperation with the United States Weather Bureau.

PUBLICATIONS.

The New York State Water Supply Commission has issued five annual reports, one progress report, and one bulletin. The annual reports set forth the work accomplished by the Commission, and have varied in size from 200 to 800 pages, with accompanying illustrations from photographs, maps, plans, and charts. The progress report was issued in 1908 and pertained to the water-power investigations. The bulletin was issued in 1909 for free distribution at the State fair, and consisted of a concise account of the scope and accomplishments of the Commission since its organization.

Of the regular reports, 2,500 copies are issued and distributed each year. The cost of distribution is borne by the Commission, but the printing is done by the State printer, under the direction of the State printing board, and the cost is charged to the State printing account and does not come out of the appropriations for the Commission. If extra copies of the report over and above the number specified by law (2,500) are desired, the Commission must bear the expense of printing the additional copies. The Commission has control over the style of its reports, the paper used, the number and kind of illustrations, and the contents.

About 500 copies of every report go to the members of the legislature and the State officers for their use and distribution. The remainder are distributed by the Commission. Copies are promptly sent to public libraries, colleges, universities, and engineering societies throughout the State, without awaiting their requests, also to persons who have requested that they be supplied with a copy of each report issued. Thereafter reports are sent to anyone making application for them. A receipt card is inclosed with each report sent out, and the receiver is asked to sign and return it.

PRESENT LINES OF WORK.

Independent investigations.—The main lines of work in which the Commission is engaged have been outlined under "Summary of laws."

Cooperation with United States Geological Survey and United States Weather Bureau.—In connection with the investigations of the Commission reliable information regarding stream flow, rainfall, and evaporation is of the utmost importance, and to obtain this information the Commission in 1907 entered into cooperative agreements with the United States Geological Survey and the United States Weather Bureau.

Under the cooperative agreement with the United States Geological Survey stream gaging has been conducted according to the standard methods of the Survey, under the supervision of one of its

district engineers, whose headquarters have been at Albany since 1909. Heretofore 12 gaging stations have been maintained, but a number of new ones will be established during the ensuing year.

In cooperation with the United States Weather Bureau eight rainfall observation stations have been maintained since 1907. These stations are equipped with standard United States Weather Bureau rain gages, maximum and minimum thermometers, and thermometer shelters. The work is under the supervision of the section director, whose headquarters are at Ithaca, N. Y. All the stations are in the Adirondack Mountains, at points from which no previous records were available. In addition to the maintenance of the foregoing stations comparative tests of four types of rain gages have been conducted through the summer seasons at the Weather Bureau stations in Ithaca. The gages employed in these tests are the De Witt conical, the Fuertes, the Smithsonian, and the United States Weather Bureau standard, two gages of each type being used. These comparative tests are made for the purpose of determining, if possible, the accuracy of older types of gages as compared with present-day standards, with a view to coordinating old records with those taken to-day under more scientific methods.

All of the existing rainfall stations will be maintained during the coming year, and 14 new stations will be established and equipped with standard gages, thermometers, etc. The new stations will be established in the basins of upper Hudson, Raquette, Oswegatchie, and Oswego Rivers.

Arrangements have recently been consummated whereby the rainfall and evaporation investigations, in addition to the stream gaging, will be carried on in cooperation with the United States Geological Survey, through its local district engineer.

Other cooperative work.—No interstate cooperative work is maintained by the New York State Water Supply Commission. In 1909, however, upon its own initiative the commission met in conference with similar commissions from the States of Pennsylvania and New Jersey, with a view to cooperating in the investigation of interstate and boundary line streams, but no definite system of cooperation has been undertaken.

There is no systematic cooperation with other scientific bureaus of the State, but wherever the duties of the State Water Supply Commission unite with or overlap the duties or jurisdiction of the department of the forest, fish and game commissioner, the department of State engineer and surveyor, the State department of health, or the public-service commission, there is a cordial interchange of data and assistance.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

BULLETIN 466

RETRACEMENT OF THE BOUNDARY LINE BETWEEN IDAHO AND WASHINGTON

FROM THE JUNCTION OF SNAKE AND CLEARWATER RIVERS NORTHWARD TO THE INTERNATIONAL BOUNDARY

R. B. MARSHALL, CHIEF GEOGRAPHER

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

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RETRACEMENT OF THE BOUNDARY LINE BETWEEN IDAHO AND WASHINGTON FROM THE JUNCTION OF SNAKE AND CLEARWATER RIVERS NORTHWARD TO THE INTERNATIONAL BOUNDARY.

R. B. MARSHALL, Chief Geographer.

INSTRUCTIONS.

The retracement of the boundary line between Idaho and Washington was provided for by the Sixtieth Congress in the sundry civil act approved May 27, 1908.

The following correspondence is self-explanatory:

DEPARTMENT OF THE INTERIOR,
Washington, June 20, 1908.

THE DIRECTOR OF THE GEOLOGICAL SURVEY.

SIR: Under date of May 30 last, your recommendation that the Geological Survey be authorized to make the survey provided for under the sundry civil bill of that portion of the boundary line between the State of Idaho and the State of Washington, from a point in the center of the Snake River opposite the mouth of the Clearwater River, thence due north to the international boundary line between the United States and the British possessions, was approved, the terms of the compensation for services being fixed at $110 per mile. Thereafter you made informal inquiry as to whether any weight should be given to the Idaho-Washington boundary line as surveyed and established by the General Land Office in 1873–74, in executing the survey of the portion of the boundary authorized by the sundry civil bill. In answer thereto you were advised on the 9th instant:

"Congress in making said appropriation did not contemplate a change in the boundary line between those States but merely the reestablishment and remarking of the line fixed by the survey of 1873, because the line had in part become obliterated.

"There is no change in the description of bounadries in the acts organizing the Territory and authorizing the admission of the State as to that part of the boundary, which is a line due north to the international boundary from a point in mid-channel of the Snake River opposite the mouth of the Clearwater River. That line was found and marked by the survey of 1873, and the purpose of the contemplated survey is to ascertain, mark, and permanently reestablish that line."

In view thereof in your letter of the 12th instant, you state that it would be impossible to make the survey at the rate fixed, namely, $110 per mile, and now recommend:

"* * * that the Geological Survey be authorized to make the survey of the Idaho-Washington boundary line for the actual cost, which may be in terms of compensation per mile as provided in the sundry civil act. I again bring to your attention the fact that the survey has men fitted both by training and actual experience in boundary-line surveys, with the necessary camp equipment and instruments already provided, and inasmuch as an inspection of the survey will not be necessary if the survey is made by the officers of the Interior Department, the cost of the survey should be much less than that for which any contractor could perform the work with the same degree of accuracy and thoroughness, added to the cost of inspection."

The provision in the sundry civil bill which provides for this survey is as follows:

"For the ascertainment, survey, marking, and permanent establishment of that portion of the boundary line between the State of Idaho and the State of Washington from a point in the center of the Snake River opposite the mouth of the Clearwater River, thence due north to the international boundary line between the United States and the British possessions, an estimated distance of one hundred and eighty-five miles, including the expense of an examination of the survey in the field, the rate of compensation per mile to the surveyor to be fixed by the Secretary of the Interior, the same to include the cost of the preparation of the plats and field notes of the survey in triplicate, twenty-five thousand dollars."

It will be seen that the Secretary of the Interior is required to fix the rate of compensation per mile for the survey, that the estimated length of the line to be surveyed is 185 miles, and that the amount of appropriation is $25,000.

The department notes fully the advantages to the Government of having the survey made by Government officers and limited to the actual cost for the making of the survey, which, in that event, would save the expense of an examination in the field, that would be necessary were the contract otherwise awarded.

Under all the circumstances, I therefore authorize that the survey be made by the Geological Survey at the actual cost, not to exceed, however, $25,000 for the completion of the entire survey, which is at the rate of $135.13 per mile, based upon the estimated length of the line to be surveyed.

Very respectfully,

FRANK PIERCE, *Acting Secretary.*

DEPARTMENT OF THE INTERIOR,
TOPOGRAPHIC BRANCH, UNITED STATES GEOLOGICAL SURVEY,
Washington, June 27, 1908.

Mr. S. S. GANNETT,
Geographer, United States Geological Survey.

SIR: The following is a copy of an item in the sundry civil bill regarding the survey of the boundary line between the States of Washington and Idaho:

"For the ascertainment, survey, marking, and permanent establishment of that portion of the boundary line between the State of Idaho and the State of Washington from a point in the center of the Snake River opposite the mouth of the Clearwater River, thence due north to the international boundary line between the United States and the British possessions, an estimated distance of one hundred and eighty-five miles, including the expense of an examination of

the survey in the field, the rate of compensation per mile to the surveyor to be fixed by the Secretary of the Interior, the same to include the cost of the preparation of the plats and field notes of the survey in triplicate, twenty-five thousand dollars."

The director in his letter of May 30, which was approved by the Secretary, making recommendations regarding the survey of this line, stated that the law above quoted involved the following provisions:

"1. The ascertainment of the longitude of the point in the center of the Snake River opposite the mouth of the Clearwater River.

"2. The accurate location of the line between the State of Idaho and the State of Washington from this point due north to its intersection with the international boundary line between the United States and the British possessions.

"3. The marking on the surface of the ground by proper monuments of the boundary as determined.

"4. The preparation of the necessary plats and field notes."

The director in this same letter made the following recommendations:

"* * * that the Geological Survey be authorized to conduct this work under instructions similar to those under which the survey of the Idaho-Montana boundary line was made, as approved by the Secretary of the Interior June 5, 1897. (See U. S. G. S. Bulletin 170, pp. 11–15.) Whatever modification of such instructions may be necessary should be agreed upon by the Commissioner of the General Land Office and the Director of the Geological Survey."

The Secretary of the Interior of June 20 stated as follows:

"Under all the circumstances, I therefore authorize that the survey be made by the Geological Survey at the actual cost, not to exceed, however, $25,000 for the completion of the entire survey, which is at the rate of $135.13 per mile, based upon the estimated length of the line to be surveyed."

In accordance with the above, you are directed to assume charge of this work immediately.

The necessary outfit for the two parties is available—part at Lewiston, Idaho, and part at Echo, Oreg.—which you should assemble at the most convenient point for use in this work.

Mr. C. L. Nelson, assistant topographer, will also be assigned to this survey, and you are instructed to generally supervise his scientific work so that it may all be done in a uniform manner.

The expenses of this survey will be paid directly in the field by Mr. Nelson, who will act as special disbursing agent. For convenience, you should approve all accounts in connection with this work.

The line should be monumented with special iron posts, set at each 1-mile interval; also with stone, or concrete posts, properly marked, at intervals of 5 miles, if practicable, and near prominent places, such as river crossings, railroads, county boundary lines, etc.

Temporary assistants should be selected, as far as practicable, from the list of applicants on file in this office. The amount of salaries to be paid will be left to your discretion, bearing in mind that the pay of teamsters, packers, and cooks should not exceed $60 per month; and that of rodmen, chainmen, and axmen should not exceed $50 per month.

The final preparation of the report to the Secretary should be similar in form to United States Geological Survey Bulletin 170, as referred to in the director's recommendation of May 30 to the Secretary.

The following is a copy of a letter of June 26 from Mr. S. V. Proudfit, Acting Commissioner of the General Land Office, the provisions of which you will observe in conjunction with the survey of the Washington-Idaho boundary line

as closely and carefully as conditions will permit, in accordance with the director's recommendation of May 30 to the Secretary:

"I have your letter of the 23d instant, informing this office that the honorable Acting Secretary on June 20, 1908, has authorized your bureau to make a resurvey of the Idaho-Washington boundary line which was provided for under the sundry civil bill at the last session of Congress (Public No. 141), and you request to be furnished with detailed instructions regarding the method to be pursued so that the work may be performed in accordance with the regulations and in a manner satisfactory to this office.

"In the letter of authorization to you by the department dated June 20, 1908, a copy of which you inclose, it is stated that some doubt having arisen as to whether the resurvey should be a new line or a restoration of the old boundary, it is decided to have the old boundary line retraced and remarked, and to that end the full amount of the appropriation, $25,000, can be used, which is at the rate of $135.13 per mile.

"In compliance with your request, I beg to recommend that the resurvey be made as follows, in order to carry out the method pursued by this office in the reestablishment of the Wyoming-Nebraska boundary line recently contracted for with Edward F. Stable, United States surveyor:

"The Idaho-Washington boundary line was run by Rollin J. Reeves in 1873, who determined the point of intersection of the Snake and Clearwater rivers as the initial point and established as his initial monument a rock 72 by 8 by 8 inches on line 32.22 chains due north thereof which is doubtless now standing.

"The ascertainment of the true point of intersection of the Snake and Clearwater rivers, as it existed at the time of the Reeves survey, does not seem to be called for specifically by the terms of the appropriation and if redetermined and found to vary considerably from the point accepted by Reeves might disturb valid existing holdings.

"It should therefore not be necessary to redetermine the point of junction of the said rivers, but the line should be taken up at the initial monument and prolonged thence by running random and true lines between original mile corners or traces thereof establishing straight lines between them, noting topography and intersections of public-land lines on each side. If necessary to locate the subdivision lines closing on the restored boundary line, the section and township lines should be retraced. Should, however, the closing corners set by the subdividing deputy be off the course found between old mileposts, the evidences should not be destroyed, but the closing corner should be placed at its proper place according to the retracement both as to distance along the line and as to alinement with the mile course.

"It will probably not be necessary to retrace over a mile each side to find public-land corners, and your notes and diagrams need only show the distance from the nearest subdivision corners, but should show the course and distance to every original closing corner, provided the traces exist.

"As the line runs through a timbered district, it is believed that no great amount of retracement for closing lines will be necessary.

"If the old closing corners are found on the line as restored, the closing lines need not be retraced to demonstrate the accuracy of the location. It would be well in this event to remove the original post or stone and to erect the iron corners over the closing point, planting the original post or stone alongside to show that the original and restored corners are practically identical.

"In the resurvey of the Nebraska-Wyoming boundary line, mile corners were perpetuated by granite monuments of cut stone 6 feet long, and closing corners by 3-inch tubular iron posts surmounted with brass caps. No half-mile corners were set by Reeves nor need be set on the restored line.

"Field notes and diagrams should be in triplicate, similar to the copy of the notes of the Reeves's boundary furnished your bureau by this office."

The matter of the expense involved in tying the Land Office closing corners to the boundary line will be taken up with the commissioner and you will be informed as soon as practicable.

You are further instructed to make such journeys and to employ such assistants as may be necessary to execute these instructions.

Any property which it may be necessary to purchase, and this should be limited as far as possible, should be paid for out of United States Geological Survey funds from the appropriation for topographic surveys.

Reports should be made in duplicate and one copy sent to Mr. T. G. Gerdine at Sacramento, Cal., and the other to me at this office. As this work lies in the Pacific division, Mr. Gerdine is, of course, in administrative charge, and I am giving these instructions direct, as it was necessary for Mr. Gerdine to leave for California before definite action could be decided upon.

Very respectfully,

R B. MARSHALL, *Chief Geographer.*

BOUNDARY LINES.

Territorial and State lines in the northwestern portion of the United States have undergone many changes. Originally this area was included partly in Louisiana and partly in Oregon, the dividing line being the crest of the Rocky Mountains.

Oregon Territory was organized August 14, 1848. It extended from the Pacific Ocean to the crest of the Rocky Mountains and from the forty-second parallel to the Canadian line. Its area at that time included the present States of Oregon, Washington, and Idaho, and portions of Wyoming and Montana. The Territory of Nebraska, formed from a portion of the Louisiana purchase, was organized May 30, 1854. Its original area extended from the Territory of Minnesota and the State of Iowa on the east to the continental watershed on the west, and from the fortieth parallel on the south to the Canadian line on the north. It included the existing State of Nebraska and portions of Colorado, Wyoming, Montana, North Dakota, and South Dakota. The Territory of Dakota was formed March 2, 1861, from a part of the Territory of Nebraska and the portion of the Territory of Minnesota not included in the State of Minnesota when that State was admitted. On March 3, 1863, the Territory of Idaho was formed of portions of Nebraska, Dakota, and Washington Territories, the latter having been organized March 2, 1853, from a portion of the Territory of Oregon. Originally Idaho contained about 324,875 square miles, but in 1864 it was reduced 146,080 square miles by the formation of the Territory of Montana, which was taken entirely from Idaho, and in 1868 it was further reduced by the formation of the Territory of Wyoming, almost the whole of which (93,995 square miles) was taken from Idaho. Idaho to-day contains about 84,800 square miles.

The present boundaries of Washington are as follows: Beginning on the coast at the mouth of Columbia River; following up the main channel of Columbia River to its point of intersection with the forty-sixth parallel of latitude; thence east on the forty-sixth parallel to Snake River; thence down the main channel of Snake River to the mouth of Clearwater River; thence north on the meridian which passes through the mouth of the Clearwater to the boundary line between the United States and the British possessions; thence west with that boundary line to the Pacific. The present boundaries of Idaho are described thus: Beginning at the intersection of the thirty-ninth meridian with the boundary line between the United States and the British possessions, it follows said meridian south until it reaches the summit of the Bitterroot Mountains; thence southeastward along the crest of the Bitterroot Range and the Continental Divide until it interesects the meridian of 34° of longitude; thence southward on this meridian to the forty-second parallel of latitude; thence west on this parallel of latitude to its intersection with a meridian drawn through the mouth of Owyhee River; north on this meridian to the mouth of Owyhee River; thence down the mid-channel of Snake River to the mouth of the Clearwater; and thence north on the meridian which passes through the mouth of the Clearwater to the boundary line between the United States and the British possessions, and east on said boundary line to the place of beginning.

The boundary under discussion is the common one mentioned above.

In the United States State boundary lines may be grouped in two general classes:

First. Those that are defined by some natural physical feature, such as an ocean or a lake shore, the channel or bank of a stream, the summit of a range of mountains, or a watershed.

Second. Those that are defined by imaginary lines which must be traced on the earth's surface by astronomic or mathematical processes. Such a line may be a meridian of longitude, a parallel of latitude, a line between two points (such as a portion of the western boundary of Nevada, which is from the intersection of the one hundred and twentieth meridian and the thirty-ninth degree of latitude to a point on Colorado River where it intersects the thirty-fifth degree of latitude), a line defined by azimuth and distance or a number of such lines consecutively joined (such as the boundary line between Maine and New Hampshire), a line determined by a given direction from a certain point terminating at its intersection with some other line (such as a portion of the western boundary of Idaho, under consideration, which runs from a point in the channel of Snake River opposite the mouth of the Clearwater due north to the thirty-ninth parallel of latitude), or a tangent or arc of a circle (such as the western and northern boundaries of Delaware).

Generally speaking, boundary lines defined by natural features need no monuments to indicate their location, but those that are determined by imaginary lines must be perpetuated by marks of some kind after their positions have been determined.

The boundary line between Idaho and Washington is made up of two sections, falling into the two classes mentioned. The first sections follows the channel of Snake River, and accordingly requires no further marking. The second section, along the meridian passing through the junction of Snake and Clearwater rivers, is the one under discussion.

ORIGINAL SURVEY.

The boundary line between Idaho and Washington was originally surveyed in 1873 by Rollin J. Reeves, under contract with the Commissioner of the General Land Office, dated June 6, 1873. The following extract from his notes describes his method of determining the initial point:

Through information gained from Capts. Stump, Coe, and Slater, all officers of the Oregon Steam Navigation Co. (the last named being present register of the land office at Lewiston), and old citizens and rivermen at Lewiston, and especially through the assistance of Mr. Silcott, the owner and conductor of the ferryboats across both rivers, I was able, after much investigation and considerable embarrassment, to determine the point "in the middle channel of Snake River, opposite the mouth of Clearwater, as it existed March 3, 1863." This was an indefinite point to ascertain, a position admitting of various interpretations and the selection of which gave me the greatest solicitude and anxiety.

Mr. Silcott aided me in making soundings to determine the channels of these rivers and in the placing of buoys.

Five different buoys of varied construction and weight were successively floated at or near the initial point. The terrible force of the water, its depth and smooth bottom, carried each of these buoys away before I could make an observation with instrument on either. I also floated a buoy (a keg) by paying out rope from a stake driven at the point of the peninsula, but the weight of the rope, which was several hundred feet long, dragged the keg under. After trying for a week, with all the assistants and all the appliances we could secure or invent, we were constrained to adopt an approximate location. I believe its location to be so nearly exact that it is correct for all practical purposes; and at any rate will not vary farther from the true position than its location by 20 engineers, acting independently of one another, and with the same data and opportunity, would all vary from one another.

Gen. Shanks, of Indiana; Gov. Bennett, of Idaho; and Gen. Milroy, superintendent of Indian affairs for Washington Territory, happening to be in Lewiston, I indicated the point selected after giving them its legal definition. They considered the location, as I had determined it, correct, although admitting the possibility of a different construction by others.

Assuming a point A on the southern shore of Snake River, in a line as nearly due south from the initial point as could be determined by sighting with solar compass to the imaginary buoy at the initial point H, I caused a stake to be driven at B on the north bank of the river, and in a line due north from A. I

now cross over to B, measure a base of 6 chains due east over the low flat surface to D. At D the line AD makes with the base BD an angle of 71° 54′. Therefore, since BDA=71° 54′, BAD=18° 6′. Now, the sine of 18° 6′ : sine 71° 54′ : : 6 chains : AB; or .3106764 : .9505157 : : 6 chains : AB. Therefore AB= 18.36 chains.

The distance AH is equal (as nearly as can be estimated) to one-third of AB or to 6.12 chains. Therefore HB=18.36 chains—6.12 chains, or 12.24 chains, which we accordingly accept and adopt. I now cause a small stake to be driven at C, which is the "nearest permanent spot on a line due north" of the initial point (H), and where is to be built the permanent initial monument.

From B, I now measure carefully the distance BC. Returning to D, I measure the angle BDC and find it equal to 73° 22′. Therefore BCD=16° 38′.

Now the sine of 16° 38 : sine 73° 22′ : : 6 chains BC, which gives BC=20 chains. Thus, we have HC=HB+BC=12.24 chains+20.08 chains=32.32 chains, which is the distance of the initial monument at C from the initial point at H.

INITIAL MONUMENT.

[August 7, 1873.]

The initial monument, which stands on the "nearest permanent spot on a direct line north," and at 32.32 chains distant from the initial point, is located in a conspicuous, accessible, and durable position. It is just at the foot of the very high bluff bordering Snake and Clearwater rivers on the north, is only a few feet north of the main-traveled wagon road from Lewiston to Walla Walla, is above high-water mark, and yet as close to the river as could be safely chosen. (See Pl. I, *A*.) It is about half a mile west of Lewiston, and a little over three-quarters of a mile west of the guide meridian, run in Idaho, parallel to this boundary, and beginning near Lewiston. The monument was constructed in the following manner, viz: First, dug a pit at least 2 feet deep by 2 feet square, in the bottom of which deposited numerous pieces of charcoal and charred wood. In the pit then planted a shaft of basaltic stone, in dimensions more than 6 feet long by 8 inches wide and 8 inches thick, smoothly and evenly dressed and engraved in characters cut plainly and deeply into the stone near its top, as follows, viz:

On the side of the shaft facing north, the inscription "1873."

On the side of the shaft facing south, the inscription "Lat. 46° 25′ 51″.96."

On the side of the shaft facing east, the inscription "I. T."

On the side of the shaft facing west, the inscription "W. T."

After placing the post with its sides to the cardinal points, in the foregoing manner, earth and stone were firmly packed and pounded about the foot of the shaft. Next dug four pits, each 3 feet deep and 3 feet square, each 10 feet distant from the foot of the shaft. One was dug due north, another due south, another due east, and another due west of the stone shaft. Built about the shaft a conical mound of earth and stone, the latter being carefully fitted and firmly packed together, and the earth pressed and sifted into all the interstices, making the mound firm and solid. It was built over 7 feet in diameter at the base, 3 feet high, tapering uniformly to the shaft, leaving the latter to project a little over a foot above the top of the mound. The stones used in building the mound were of various sizes, small and large, heavy round bowlders, found in great abundance along the river shore.

The initial monument is witnessed in the following manner, viz:

1. The sharp apex of the highest peak on the west bears (from the initial *shaft*) N. 63° 7′ W., estimated distance 3¼ miles.

A. VIEW AT JUNCTION OF CLEARWATER AND SNAKE RIVERS.

B. SPIRIT LAKE, IDAHO.

2. The next lower rocky peak bears N. 69° 47′ W., estimated distance 3¾ miles.

3. A lone pine tree near bank of Snake River, and at the mouth of a gulch, bears N. 88° 21′ W., estimated distance 2½ miles.

4. Bush on point of bluff bears S. 89° 52′ W., estimated distance 4¼ miles.

5. The larger one of two trees situated across bend of river near its banks bears S. 83° 25′ W., estimated distance 3⅛ miles.

6. The face of a bold bluff across Snake River, opposite the lower ferry, bears S. 69° 58′ W., estimated distance 4½ miles.

7. The face of a small but prominent bluff, looking southerly across Snake River, bears S. 14° 33′ W., estimated distance 3¼ miles.

8. The point where the bar cuts the face of bluff opposite the last mentioned bluff bears S. 7° 50′ W., estimated distance 3½ miles.

9. The highest point of land, looking southerly, bears S. 7° 30′ E., estimated distance 5 miles.

10. Easterly ferry-wire support on Snake River bears S. 15° E., estimated distance 7⅛ miles.

11. Westerly flagstaff standing in Lewiston, estimated distance three-fourths of a mile, bears S. 35° 59′ E.

12. Cupola of schoolhouse in Lewiston bears S. 44° 56′ E., 1⅜ miles distant.

13. The lone pine tree on sand bar on north shore of Clearwater River bears S. 48° 3′ E., three-eighths mile distant.

14. The northerly ferry post on Clearwater River bears S. 65° 42′ E., one-half mile distant.

15. The nearest and lowest point of bluff seen over the lower bluff at Clearwater Ferry bears S. 67° 18′ E., estimated distance 5 miles.

16. The anchor for ferry wire bears S. 71° 30′ E., estimated distance one-half mile.

17. The top of a rock lying near foot of bluff, sloping to the road, bears S. 89° 1′ E., distance 18 chains.

18. The highest point of bluff looking northeast bears N. 47° 35′ E., distance 10 chains.

19. The face of a rock lying on the easterly side of a gulch bears N. 5° 42′ E., 7 chains distance.

Mr. Seth G. Slater, the register of the United States land office at Lewiston, in mentioning this monument, wrote: "It is a far better job than I thought could have been accomplished. The work is well done and the monument all that could be wished for."

Even at that time the rich mesa (Palouse) country just north of Lewiston had begun to attract settlers, and Mr. Reeves speaks of scattered fenced-in holdings where grain and vegetables grew abundantly. Cattle owned by the whites and bands of horses belonging to the Indians found an excellent range on this plateau.

Then, passing through the timbered country farther north, Mr. Reeves says of milepost 121:

This post stands in a beautiful natural pine park, large open timber, with zones of pine, fir, and hemlock thickets.

On retracing the line, the bottom of this post was found in the center of a street of Newport, a flourishing town with two railroads.

Mr. Reeves made a raft of logs to cross Clark Fork at this point and at the south end of Rat Island blazed and marked a cottonwood

tree as a witness post to milepost 122. This tree was found with the blaze completely overgrown and with no sign of a scar on the bark. The illustration (Pl. II, *B*) shows the depth to which the tree had to be cut to expose the old inscription, which was then perfectly clear.

From this point northward it was a race between the party and the approaching winter, the increasing difficulty of advancing, due to rugged topography, thickets, and snow, finally compelling them to turn back when but a little more than a mile from the international boundary.

The following extracts are taken from Mr. Reeves's notes:

Mile 172. Mountainous country of the roughest character, timber nearly completely burned and fallen; the trees that remain standing are nearly all dead from the effects of fire. Many large loose bowlders lie scattered over the surface. Soil burned to ashes. Great quantities of fallen timber over the entire mile. The work is of the most discouraging character imaginable.

Mile 173. Land rises constantly but very gradually toward the north. This mile has followed along the foothills of a range whose summit is considerably west of the line, the foothills all sloping toward the east. Most of the timber has been burned and fallen, which, with large bowlders and plenty of rock, makes our progress discouragingly slow. On the last half mile there is a heavy growth of small alders. This mile has caused the greatest labor of any since leaving Lewiston. It snowed about 2 inches last night and there was a continuation of the storm during the day. The ground, brush, and trees have been covered with snow, making all hands cold, wet, and wretched during the entire day.

Mile 174. The weather has been cold and clear all day, the ground covered with snow several inches thick.

Mile 175. The line now (27.50 chains from milepost 174) follows a steep, brushy hillside which slopes toward the east at an angle of about 45°; besides the brush the surface is covered with loose basaltic rock which, being covered with snow, renders our progress slow and almost perilous.

* * * * * * *

Numerous logs, stumps, and large bowlders are crossed every few chains; these, together with the abruptness of the grade, loose stones, thick underbrush, snow, cold, and general exhaustion, have rendered the establishment of this mile one of the most difficult, tedious, and painful of the entire boundary.

Mile 176. October 25, 1873. There is from 4 to 6 inches of snow on the ground and every prospect of more falling before night. * * * We are now ascending a high, steep mountain covered with small timber, dense underbrush, but much less down timber. Granite outcroppings, in area of 1 to 5 acres, are seen on the south side of the mountain. The ground is covered with snow about 4 inches deep. Everything has the appearance of midwinter.

Mile 176½. Having run out the first half mile from the one hundred and seventy-sixth milepost, it being almost dark and nearly 2 miles to camp, over a road of the very roughest character, and fearing that we would not be able to return to this point again this season, we here set milepost 176½. * * * This entire half mile has been ascending the south side of a mountain, and the post stands about half a mile below (south of) the apparent summit. The timber is scattering and of stinted growth, being mostly black pine, fir, and some alder. Soil very shallow and rocky, fourth rate.

A. VISTA CUT ALONG BOUNDARY LINE.

B. BLOCKING A WITNESS TREE.

Here ended the possibility of proceeding upon the line during this season. Last night the cook made bread of the entire quantity of flour remaining, all other provisions having been exhausted. This morning the bread was rationed out to the men, each one receiving five or six small loaves with the information that no other could be furnished until they returned to the camp where the provisions were deposited and the pack animals were left. This latter camp was near the summit of a mountain between the one hundred and sixtieth and one hundred and sixty-first miles and about half a mile east of the line, where was found the last vestige of grass on the entire route. All hands now proceeded to cut down trees and otherwise clear the view, thus enabling Mr. Denison to make final observations for latitude. He and several assistants were engaged during the entire night in endeavoring to secure observations. The result, however, was not satisfactory. It was too cloudy and cold, the thermometer indicating 10° F.

In the morning we commenced retracing our line to the main supply camp above mentioned. A portion of the instruments, tools, and extra luggage were cached at this camp (176½ miles). After three days of unremitting toil we arrived at the main camp, our provisions completely exhausted, and our strength nearly so. By this time we were thoroughly convinced that to have remained only a day or two longer in endeavoring to push the work to its completion would have been fatal. During the last day that we worked in establishing the line, two members of the party went ahead 3 to 4 miles, prospecting for the international boundary line (latitude 49°).

Trees were found blazed and two cut square off as if for observations. These were about 2½ miles from (north of) the last camp. From the main supply camp we were employed 10 days in retracing our line to the first white settlement at Spokane Bridge (90-mile air line), which we had left on the 2d day of September. Remaining here two days resting and getting fresh supplies of provisions, we started on our return to Lewiston, where we arrived after one week's travel, and where the party was disbanded.

With a knowledge of the country traversed, as it is to-day, one can but marvel at the persistance and hardihood of that party of men who did not falter until actual lack of food compelled retreat. At their northernmost point they were nearly 90 miles from Spokane Bridge, the nearest white settlement—90 miles of mountains, windfall forests, and thickets, of zero weather, and snow.

In the retracement few of these difficulties were encountered. Steamers on Priest Lake landed supplies only 20 miles from the international boundary. The northernmost end of the line, the most difficult, was retraced during August and September, the best time of the year.

DESCRIPTION OF OPERATIONS.

The retracement of the Idaho-Washington boundary line was commenced July 11, 1908, from the initial monument near Lewiston, Idaho, and continued northward. The work was begun by S. S. Gannett, geographer, using a Young solar transit No. 64, and C. L. Nelson, assistant topographer, using a Young solar transit No. 66.

METHODS.

After a careful test of the stadia interval of the instruments, the stadia method was used, as the country was in general either rolling or mountainous.

Rod levels were used on the rods. Two turns were taken for each set up, so that the results are really the average of a twice-run line. The average discrepancy between the two stadia lines was 6 feet to the mile. As the country was rough, this result was considered superior to the probable result from chaining.

Miles 1 to 3 were run by Mr. Gannett and Mr. Nelson in conjunction. Afterwards two camps were formed. Mr. Gannett ran miles 16 to 50 and 81 to 117; Mr. Nelson ran miles 3 to 16, 50 to 81, and 117 to 121. The line was run as a random line, sometimes in a northerly direction and sometimes in a southerly direction.

To avoid confusion, the lines are given in the final notes to read consecutively and on the true line. To prevent chance of error in alignment, the line was run on fore and back sights between corners and solar observations made there.

TOPOGRAPHY.

After climbing the bluff north of Snake River, the line runs northward over a rolling plateau, called locally the Palouse country. Wheat is the principal crop, but the soil is fertile and the small orchards around farmhouses prove that it could easily be made an excellent fruit country. The general impression of prosperity is such as one might expect to find in a fertile Mississippi Valley section. The physical characteristics of this district are shown in Pl. III, *A*, which represents a typical view in the Palouse country.

The line passes near Moscow, where the University of Idaho is located, then continues northward through rich agricultural country, passing over hills on either side of Farmington, the first rough, untilled country on the plateau.

Continuing north the State line forms the western boundary of the Cœur d'Alene Indian Reservation. The Indians live much like white settlers, with substantial frame ranch houses and barns, and buggies to take them to town. Here and there a wikiup would appear in a dooryard, but whether set up simply as a relic of the past or as an actual refuge when proper civilization becomes too onerous the writer has no knowledge.

Toward the north end of the reservation scattering pine and fir timber begin to appear, while at the northern boundary, near the State line, a sawmill is at work in the center of a very good stand. Leaving the reservation the line crosses Mica Mountain, through

A. VIEW AT MILEPOST 13.

B. VIEW AT MILEPOST 51.

timber and brush, and descends the north side into Spokane Valley. (See Pl. III, *B*.) Irrigation is being introduced into this valley, and the orchards are responding in a very encouraging manner.

The line again strikes into the hills north of the valley, on which the timber increases as Spirit Lake is approached. (See Pl. I, *B*.) The line west of this lake passes through virgin forest, into which a large sawmill at Spirit Lake has just begun to cut. Pack animals were found necessary through the mountains here, and the serious work of the axman began. Practically continuous chopping was necessary from this place northward. (See Pl. II, *A*.)

In Blanchard Creek valley small settlers' clearings begin to appear. Two small sawmills fill the local demand for timber.

As Newport is approached the hills disappear and a heavily timbered plateau, with hardly any relief, extends northward to the town. An extensive experiment is being undertaken at the northern edge of this plateau overlooking the town. The forest is being cleared, the stumps uprooted, and fruit trees planted. The trees have not yet come into bearing but are growing well. The small patches of potatoes, strawberries, etc., in this clearing have produced so well that it seems certain that the entire plateau will eventually be cleared for agriculture.

Newport was reached on October 9, 1908. Extensive rains and more recent snow flurries suggested that it would be wise to postpone the field work until the following spring. The parties accordingly disbanded here. The camp outfits were stored, the stock was turned over to a rancher for the winter, and Mr. Gannett and Mr. Nelson returned to Washington.

On May 1, 1909, Mr. Nelson, with S. G. Lunde, arrived at Newport, organized a party, and resumed work. Bayard Knock organized a party of three men to map the country traversed the preceding season by the retracement parties. Mr. Knock's party turned south, while the other party continued northward on the retracement.

The line on leaving Newport crosses Clark Fork, striking Kellys Island and Rat Island. The valley north of the river is narrow. After passing this strip and surmounting the river bluff, the line traverses a plateau, evidently on the same level and apparently of the same formation as that south of Newport. Settlers with small clearings near the shores of two beautiful lakes are the last for some 10 miles in traveling northward. The country here becomes a wilderness which, with the exception of a few meadows farther north, remains unbroken to the international boundary.

The north end of the line is the highest and the most difficult of access, and it was decided to retrace this portion during the best part of the season. Accordingly, after reaching milepost 127, the party

returned to Clark Fork and moved the wagon camp to Coolin, via Priest River. The wagon and heavier camp equipment were left there. Pack outfits and animals were put aboard a barge and steamer, taken toward the upper end of Priest Lake, and unloaded at Reeder Creek cabin.

The party then took the Granite Creek trail, carrying stadia elevations from the lake at Reeder Creek. Granite Creek was swollen by the June floods, and it was with some difficulty that it was forded.

A couple of miles farther on the trail brought the party close to the line and all blazes were carefully examined. Finally scars were found, the overgrowing rings of which showed the blaze to be approximately 36 years old. After making camp, the party followed the line to an old milepost (156) and the retracement work was resumed. The illustration of a section of a witness tree on this line (Pl. IV) shows clearly how closely the age of a blazed line may be determined from counting the rings of annual growth.

An old lateral moraine to the south and glacial striæ on exposed ledges farther to the north give very conclusive evidence of the work of glaciers in this region.

Near this camp the traverse man's path was successfully disputed for the time being by a large bear. The party continued northward without mishap, however, until the international boundary was reached on August 29, 1909. The last section of a little over a mile was original survey, as the party of 1873 did not reach the Canadian line.

This country was rugged, and the dense thickets on old burns and many windfalls made the packer's task a difficult one. Occasionally the whole force had to turn to with axes to cut a trail for the animals.

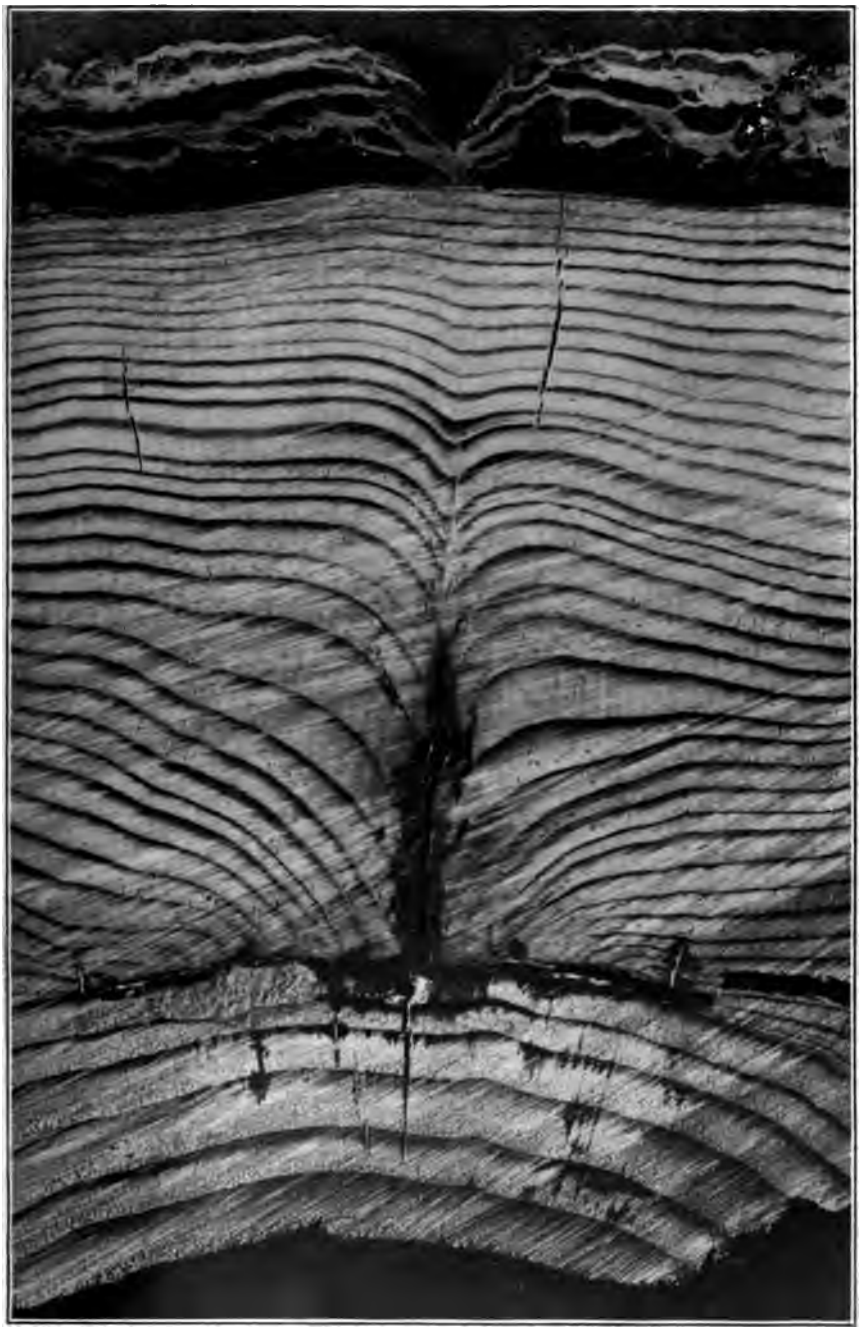
In the meantime Mr. Lunde had returned to Newport and organized a party to retrace the line northward from milepost 127. The other party, working southward from milepost 157, met his party near milepost 144 on October 17, 1909.

Mr. Knock, who had completed the strip of topography below Newport, accompanied Mr. Lunde as he retraced the line and mapped the topography covered by the party. In Mr. Nelson's party the topography had been carried on with the line work, aided by foot traverse work by Messrs. De Long and Hines.

The parties now returned to Newport, where the outfits were stored, and disbanded, Mr. Nelson returning to Washington to prepare the notes and plat and Mr. Lunde going to Sacramento, Cal., on other survey work.

MONUMENTS.

In re-marking the line it was decided to replace the old posts with more permanent ones. In general wrought-iron posts 6 feet long and 4 inches in diameter were used. (See fig. 1, *e*.) They were



SECTION OF FIR WITNESS TREE, SHOWING ANNULAR GROWTH.

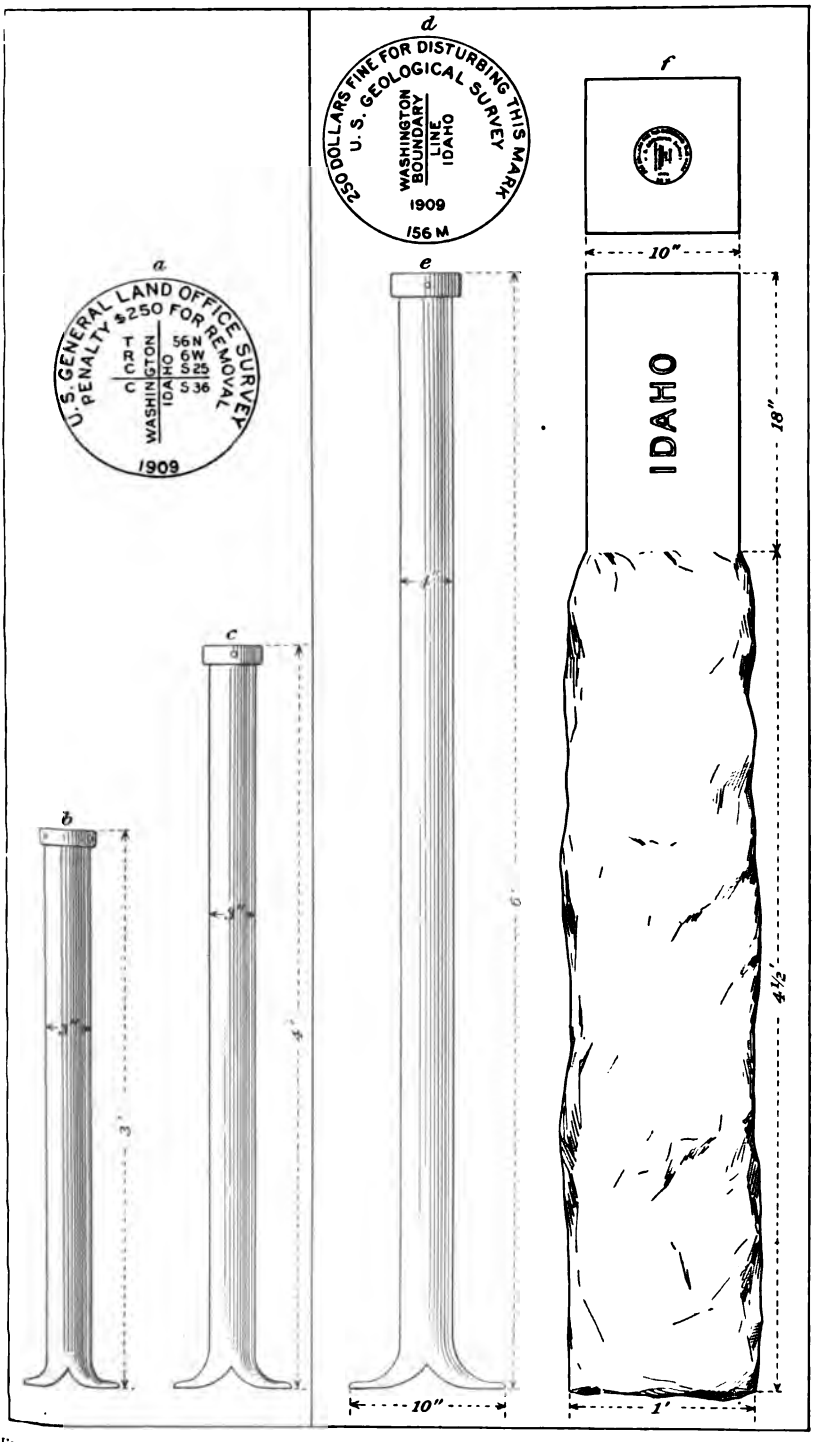


FIGURE 1.—Designs for iron post, stone monument, and iron closing-corner post Bronze cap for iron closing-corner post, U. S. General Land Office; *b*, *c*, iron c' corner posts, U. S. General Land Office; *d*, bronze cap for iron milepost; *e*, ir post; *f*, granite monument (top and side views).

flanged at the bottom and had a bronze cap on the top which bore the inscription (fig. 1, *d*). These posts were filled with concrete, so that even when the iron might rust and disintegrate the concrete would mark the spot. These posts were supplied by a St. Louis firm, at a cost of $2.40 each, unfilled.

Wherever practicable, granite monuments 6 feet long and 1 foot square, with the upper 18 inches dressed, were erected at 5-mile intervals. They bore the inscription "Washington" on one side, "Idaho" on the other, and the number of miles from the south end of the line on the south face. (See fig. 1, *f*.) A bronze tablet was cemented into the top, carrying an inscription similar to those appearing on the bronze caps of the iron posts. These monuments came from a quarry at Medical Lake, Wash., and cost $17 each. The weight of the granite monuments was a little more than 800 pounds, however, and this precluded their use where the position was not easily accessible. The 5-mile interval was therefore not maintained throughout the distance. With the exception of milepost 123, north of Newport, it was found to be inexpedient to use these granite monuments north of Clark Fork, as a 90-pound iron post filled with concrete often taxed the resources of the men along the rougher portions of the line.

The closing corners were wrought-iron posts, with a flange at the bottom. (See fig. 1, *a*, *b*, *c*.) They were 3 inches in diameter and of two lengths, 3 and 4 feet. These also were filled with concrete. Where the position of the old closing corner was doubtful no new corner was set, but where the position was apparent the new post was set on a straight line between the mileposts on either side and opposite the position of the old post.

In the Palouse country, where a road followed the line for a part of its length and cultivated fields and fences were encountered, the traces of the old mileposts were difficult to find. Under these circumstances the positions of the posts were determined by adjusting the distances and falling between the found posts. After this adjustment had been made, the rotten bottom of the old post was often uncovered when the hole was being dug for the new post, although there were absolutely no surface indications of its presence; as, for example, in such places as a graded road or along the ridge thrown up by plowing along a fence.

In the timber the positions of all the old mileposts were located by actual remains of the posts witnessed by bearing trees. The inscriptions on them were often completely overgrown, but were always found clear and in accordance with the old notes when exposed by chopping. In some places fire had apparently destroyed all evidences of the former survey, but careful search would invariably uncover some clue. In a few places bronze tablets were inserted in native

rock to mark the position of the milepost. At the intersection with the international boundary a rock monument was built from flat rocks found in the vicinity. Cement mortar was used, and the top was finished with a cap of neat cement with a bronze tablet inserted in the top.

DESCRIPTIONS OF MONUMENTS.

A general description of the mileposts is given below. Bearing trees were marked where the posts fall in timber, a full description of which will be found in the notes filed with the General Land Office.

Initial monument: Basalt shaft, 72 by 8 by 12 inches, 4.5 feet above surface of ground, in circular mound of rock 7 feet in diameter, 3½ feet high. Shaft is marked "1873" on north side, "W. T." on west side, "Lat. 46:25-51:96" on south side, and "I. T." on east side. Southeast and northwest barbed-wire fence, 9 links south of initial monument, marks the south side of the Oregon-Washington Railroad & Navigation Co.'s right of way. The monument is in an excellent state of preservation and was not replaced. (See Pl. I, *A*.)

1. Iron post 6 feet long, 4 inches in diameter, filled with concrete; brass cap stamped "1908 1 M." On account of bedrock, this post is set only 18 inches in the ground, surrounded with a rock mound, 3 feet in diameter, 2.5 feet high. Traces of milepost 1, a pile of rocks 2 by 2 feet on southeast slope of hill, and remains of old post in ground were found.

2. Iron post 6 feet long, 4 inches in diameter, filled with concrete, projecting 3 feet above ground. A mound of earth was placed around post and pits dug 6 feet north and 6 feet south. Post marked "1908 2 M." Evidences of old corner: Post not in place, 2 pits on line, 1 pit 1 foot east of line. Found squared timber 6 inches square, 4 feet high, 50 feet downhill to southwest, marked as described in old notes. In digging found rotten bottom of old post between north and south pits.

3. Iron post 6 feet long, 4 inches in diameter, filled with concrete, 1 foot north of east and west fence bearing west, and under north and south fence, projecting 3 feet above ground, marked "1908 3 M." On account of fence no pits were dug. Old corner indicated by old fence line. Remains of old post found at fence corner, not in place, only marks visible being "1873." In digging found pieces of rotted wood, apparently remains of old corner.

4. Iron post 6 feet long, 4 inches in diameter, filled with concrete, at fence corner, marked "1908 4 M." Pits 6 feet north and south of post. Fence corner was found in old mound with traces of pits to the north and south. Basalt stone 3 by 8 by 16 inches was found in top of mound, and in digging rotten base of old corner post, with charred block of wood at bottom, was found.

5. Granite monument 6 feet long, 1 foot square, with upper 18 inches dressed, marked "Idaho" on east side, "Washington" on west side, and "5 M." on south side. A bronze cap inserted in the top of monument is marked "1908 5 m." The monument is set on fence line between two grain fields, where rotten bottom of old post with charred block at the base was found by digging. There were no surface marks.

6. Iron post 6 feet long, 4 inches in diameter, marked "1908 6 M.", on north-south fence between grain field on the west and pasture on the east, with pits 6 feet north and 6 feet south. No traces of old corner were found, but position of post was adjusted between found corners 5 and 8.

7. Iron post 6 feet long, 4 inches in diameter, marked "1908 7 M.", on fence line, with mound of earth built around it and pits 6 feet north and 6 feet south. No evidences of old post were found, but position was adjusted between found corners 5 and 8.

8. Iron post 6 feet long, 4 inches in diameter, marked "1908 8 M.", on north-south fence line, with pits 6 feet north and 6 feet south. Old squared pine post marked "1873", "I. T.", and "W. T." on its respective faces, was found lying on the ground, and in digging on fence line remains of bottom of post, with charred and decayed pieces of pine at the bottom, were found.

9. Iron post 6 feet long, 4 inches in diameter, marked "1908 9 M.", in large wheat field 40 feet south of slight drain bearing east. The post stands in a grain field, and no pits were dug, but a mound was built around post. No traces of old post were found, although a double furrow 5 links to the east might have offered slight evidence of old line. Position was adjusted between found posts 8 and 14.

10. Granite monument 6 feet long, 1 foot square, with top 18 inches dressed and projecting aboveground, marked "Idaho" on east side, "Washington" on west side, with bronze cap set in top, stamped "1908 10 M." Monument is set in garden 76 feet south of Henry Mengelkamp's house and 15 feet south of south fence of second-class road at north end of willow hedge and about 4 feet east of it. No trace of old milepost 10 was found, but position was adjusted between found corners 8 and 14.

11. Iron post 6 feet long, 4 inches in diameter, marked "1908 11 M.", on north slope near top of spur. No pits were dug, as the post falls in a wheat field. Found no trace of old milepost 11; there were no fence lines or other evidences. Position was adjusted between found posts 8 and 14.

12. Iron post 6 feet long, 4 inches in diameter, marked "1908 12 M.", on fence line on top of spur sloping east between two grain fields. Pits were dug 6 feet north and 6 feet south of post and conical mound of earth placed around post. No evidences of old post were found, but position was adjusted between found posts 8 and 14.

13. Iron post 6 feet long, 4 inches in diameter, marked "1908 13 M.", in small adobe flat, with pits 6 feet north and 6 feet south, and mound of earth around post. (See Pl. III, *A*.) No traces of old milepost 13 were found, but position was adjusted between found posts 8 and 14.

14. Iron post 6 feet long, 4 inches in diameter, marked "1908 14 M." Post is set on south side of a buried rock that was found on fence line, evidently set in black loam. This rock was 2 by 10 feet at top and 10 by 10 feet at bottom, and its position corresponds to description of old post, as drain crossings are noted 1 chain and 4 chains north of post 14, the real distances being 0.99 chain and 4.13 chains. The course of the drains agree with those of the old notes. As new post falls on hog-proof fence, no pits were dug. A stone 12 by 12 by 4 inches was set at foot of post and a stone (quartzite) mound was built around post.

15. Granite monument 6 feet by 12 inches, square, with upper 18 inches dressed to 10 inches square, engraved "Idaho" on east side, "Washington" on west side, "15 M." on south side, with brass cap in top stamped "1908 15 M.", set on a fence line on north slope of hill. The old timber boundary post, 5 inches square, was found standing 4 feet above ground, marked "1873" on north side, "15" on south side, "I. T." on east side, and "W. T." on west side.

16. Iron post 6 feet long, 4 inches in diameter, filled with concrete, with brass cap set in top stamped "1908 16 M.", set 3 feet in the ground, at intersection of fence east with north and south fence, in clump of choke cherries on southwest slope. The land on the west belongs to W. H. Hawley, on the south-

east to John Naylor, and on the northeast to Frank Slater. Original milepost 16 was found in good condition, marked as described in land-survey notes. This post was reset by W. H. Hawley in 1898.

17. Iron post 6 feet long, 4 inches in diameter, marked "1908 17 M.", set 3 feet in ground where remains of old wooden milepost 17 were found under a north and south fence 0.65 chain north of fence east.

Though diligent search was made, no mileposts could be found between the seventeenth and twenty-second corners. The distance between these corners was found to be 391.55 chains, and the falling 0.00 chains; the true bearing is therefore due north. As, according to notes furnished by the Commissioner of the General Land Office, mile 17–18 was rechained during the subdivision of T. 14 N., R. 46 E., and found to be 10 chains short, a measurement which agreed with the short measurement (391.55 chains) made of the total 5-mile distance between the seventeenth and twenty-second corners, 70 chains was accepted as length of the eighteenth mile, and 80.39 chains as length of each of the other 4 miles.

18. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 18 M.," set 3 feet in ground, 70 chains north of milepost 17, in wheat field sloping west by south; 1.5 chains from bottom of each branch of small draw, 8.05 chains north of fence corner, and 8.45 chains south of east and west fence. Bearing pits 2 feet square and 2 feet deep were dug 6 feet north and 6 feet south of post.

19. Iron post 6 feet long, 4 inches in diameter, filled with concrete, 3 feet in ground, marked "1908 19 M.", 2 links west of fence on northeast slope, near bottom of draw, with bearing pits 2 feet square and 2 feet deep, 6 feet north and 6 feet south.

20. Iron post 6 feet long, 4 inches in diameter, filled with concrete, 3 feet in ground, marked "1908 20 M.", under State-line fence on cultivated land, sloping south, about 9 chains east of a row of poplars. Partly timbered butte bears S. 85° 50′ E., 5 miles; large red barn bears S. 85° E.; north tree of row of poplars bears N. 79° 20′ W.; south tree of row of poplars bears S. 68° 15′ W. Bearing pits 2 feet deep, 6 feet north and 6 feet south of post.

21. Iron post 6 feet long, 4 inches in diameter, filled with concrete, set 3 feet in ground, under north and south fence, marked "1908 21 M.", with bearing pits 2 feet deep, 6 feet north and 6 feet south, land on west owned by Arthur Gosselin, land on east owned by Samuel Long, cupola on Mr. Long's barn bearing N. 34° 40′ E., highest peak of Moscow Mountains bearing N. 57° 8′ E., Moscow water tower bearing N. 75° 40′ E., chimney on small red house bearing S. 83° 5′ E.

22. Granite monument, 6 feet long, depressed 10 inches square on top and on sides for 18 inches below top, marked "Washington" on west, "Idaho" on east, and "22 M." on south, with brass tablet similar to brass caps of iron posts, countersunk in center of top, stamped "1908 22 M." Iron post was set in place of old pine milepost 22, which was found in good condition, 0.5 miles northeast of house of Arthur Gosselin, marked as described in notes furnished by the Commissioner of the General Land Office.

No traces of mileposts could be found between the twenty-second and twenty-fifth corners. The distance between these corners was found to be 241.36 chains, and the falling 35 links east; the true bearing is therefore N. 5′ W. and the length of each mile 80.45 chains.

23. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 23 M.", 3 feet in ground under State-line fence. In digging hole for this post, stump of old milepost was found.

24. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 24 M.", set 3 feet in ground in wheat field belonging to John Thompson, on northwest slope, about 3 chains southeast of lane, with bearing pits 6 feet north and 6 feet south.

25. Granite monument, 6 feet long, dressed to 10 inches square on top and on sides 18 inches down from top, set 3 feet in ground, marked "Washington" on west, "Idaho" on east, and "25 M." on south, with brass cap stamped "1908 25 M." countersunk and cemented in top. This monument was set in place of old milepost 25, a decayed wooden post, with most of the original marks obliterated, which was found on northeast slope, in a clump of service bushes and buck brush.

No mileposts could be found between the twenty-fifth and thirtieth corners. The distance between these corners was found to be 402.95 chains, and the falling 46 links to the west; the true bearing is therefore N. 4′ E., and the length of each mile 80.59 chains, except as noted for miles 27 and 28.

26. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 26 M.", set 3 feet in ground in wheat field on northeast slope on land belonging to Fred Goiser, 4.2 chains south of drain, with chimney on Mr. Goiser's house about 11 chains distant, bearing N. 61° 45′ W. Pitts were dug 2 feet deep, 6 feet north and 6 feet south of post.

27. Iron post, 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 27 M.", set 3 feet in ground at turn in lane on north side and at foot of high fill of Spokane Inland Empire Electric Railroad. Rocks were piled around post, and pits dug 2 feet deep, 4 feet north and 4 feet south. Southwest corner of red barn of P. T. Powe 1.98 chains distant, bearing N. 11° 45′ E. As the true position of milepost 27, at 80.59 chains, comes on top of embankment of electric road just being constructed, the post was set 0.81 chain north in solid ground.

28. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 28 M.", set 3 feet in ground under west fence of lane west of Joe Beck's orchard and house, with pits 2 feet deep, 6 feet north and 6 feet south of post.

29. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 29 M.", set 3 feet in ground under north and south fence, 6.02 chains south of fence west, 2.03 chains south of township corner, with pits 2 feet deep, 6 feet north and 6 feet south of post.

30. Granite monument 6 feet long, dressed to 10 inches square on top and on sides for 18 inches down from top, marked "Washington" on west, "Idaho" on east, and "30 M." on south, with brass tablet marked "1908 30 M." countersunk and cemented in top. The monument is located about 3 chains northeast of house of W. A. Garrell and 1.8 chains east of his well. It is 4.75 chains south of electric car track and 12.88 chains south of main wagon road, and is on the south side and at nearly the lowest point of the valley. Traces of old rotted milepost 30 were found under State-line fence.

31. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 31 M.", set 3 feet in ground, with pits 2 feet deep, 6 feet north and 6 feet south. Rotten butt of old cedar milepost was found.

No mileposts were found between the thirty-first and thiry-fourth corners. The distance between these corners was found to be 241.32 chains and the falling 119 links west; the true bearing is therefore N. 17′ E., and the length of each mile 80.44 chains.

32. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 32 M.", set 3 feet in ground under State-line fence on west side of lane, with jack pine and brush on west of lane. The land on the west belongs to Ernst Meinig, and the cultivated field on the east to Homer McClung. Pits 2 feet deep were dug 6 feet north and 6 feet south of post.

33. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 33 M.", set 3 feet in ground on gentle north slope about 6 chains south of drain in cultivated field, 27 chains south of road, with pits 2 feet deep, 6 feet north and 6 feet south.

34. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 34 M.", set 3 feet in ground, 20 feet south of fence east on line between sections 1 and 12, township 41 north, range 6 west. Land on both sides of State line is cultivated; that on the east is owned by C. W. Foster. Rotted stump of old pine post was found on land sloping south.

35. Granite monument 6 feet long, dressed 10 inches square on top and on sides for 18 inches down from top, 3 feet in ground, marked "Washington" on west, "Idaho" on east, and "35 M." on south, with brass tablet stamped "1908 35 M." countersunk and cemented in top. Remains of old square pine post were found in mound of earth.

36. Iron post 6 feet long, 4 inches in diameter, filled with concrete, 3 feet in ground, marked "1908 36 M." This post was set in place of original milepost 36, which was found in mound of earth under fence, and pits were dug 8 feet north and 8 feet south. Post is on cultivated land, sloping north, just north of top of low ridge; ground covered with low brush.

37. Iron post 6 feet long, 4 inches in diameter, filled with concrete, 3 feet in ground, marked "1908 37 M." Post is near top of low ridge and in a line of brush 8 feet wide; it is 1.71 chains south of west fence, 1.2 chains west of fence running northwest to section corner. Rotted butt of original square milepost 37 was found between indications of pits 6 feet north and south.

No mileposts could be found between the thirty-seventh and thirty-ninth corners. The distance between these corners was found to be 160.62 chains, and the falling 23 links to the east; the true bearing is therefore N. 05′ W., and the length of each mile 80.31 chains.

38. Iron post 6 feet long, 4 inches in diameter, filled with concrete, 3 feet in ground, marked "1908 38 M.", 2 links west of north and south rail fence about 1.2 chains east of small grove of apple, lilac, and poplar trees, with pits 2 feet deep 6 feet north and 6 feet south.

39. Iron post 6 feet long, 4 inches in diameter, filled with concrete, 3 feet in ground, marked "1908 39 M." Post is 0.23 chains east of road and about 1.2 chains north of gate to yard in front of Mrs. Drew's house. Pits 2 feet deep were dug 6 feet north and 6 feet south. A mound, with pits 6 feet north and 6 feet south, was found 10 feet west of fence along east side of road.

40. Granite monument 6 feet long, dressed 10 inches square on top and on sides 18 inches down from top, marked "Washington" on west, "Idaho" on east, and "40 M." on south, with brass tablet countersunk and cemented in top, stamped "1908 40 M." This monument is set 3 feet in ground. Rotted stump of old square milepost was found in west edge of wagon track, 27 feet east of fence on west side of road and 27 feet west of fence on east side of road.

41. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 41 M.", set 3 feet in ground in place of rotted stump of squared pine post, which was found in mound about 3 chains northwest of junction of north and south road with road east. Pits 2 feet deep were dug 6 feet north and 6 feet south.

42. Iron post 6 feet long, 4 inches in diameter, filled with concrete, 3 feet in ground, marked "1908 42 M.", set in place of rotted stump of squared pine post, which was found 3 feet east of fence along west side of road. Pits were dug 2 feet deep 6 feet north and 6 feet south. Falling is 3 feet east of random line; hence, true line is 2 feet east of random line, or due north.

No mileposts were found between the forty-second and forty-fourth corners. The distance between these corners was found to be 159.74 chains, and the falling 0.00 links. The true bearing is therefore north, and the length of each mile 79.87 chains.

43. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 43 M." This post is set 3 feet in ground, and is located in a field used as a pasture; it is 2.83 chains north of center of east and west road, in valley south of Stratton Butte. Pits 2 feet deep were dug 6 feet north and 6 feet south.

44. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 44 M.", set 3 feet in ground, 0.27 chains north of a fence running east and 0.12 chains east of north and south fence. Pits were dug 6 feet north and 6 feet south. Butt of rotted pine post was found on south slope of Stratton Butte, about 5 chains below top. Traces of mound and pits north and south were also found.

45. Granite monument 6 feet long, dressed 10 inches square on top and on sides 18 inches down from top, marked "Washington" on west, "Idaho" on east, and "45 M." on south, with brass tablet stamped "1908 45 M." countersunk and cemented in top. Monument is set 3 feet in ground; no pits were dug. Butt of rotted pine post was found under fence on east edge of cemetery 0.5 mile southeast of Farmington, Wash.

No mileposts were found between the forty-fifth and forty-seventh corners. The distance between these corners was found to be 160.40 chains and the falling 9 links to the west; the true bearing is therefore N. 02′ E., and the length of each mile 80.20 chains.

46. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 46 M.", set 3 feet in ground, on northeast border of Farmington. Land on east is owned by Adin Davis and that on the west by C. W. Russell. Post is set under State-line fence, with pits 2 feet deep, 6 feet north, and 6 feet south.

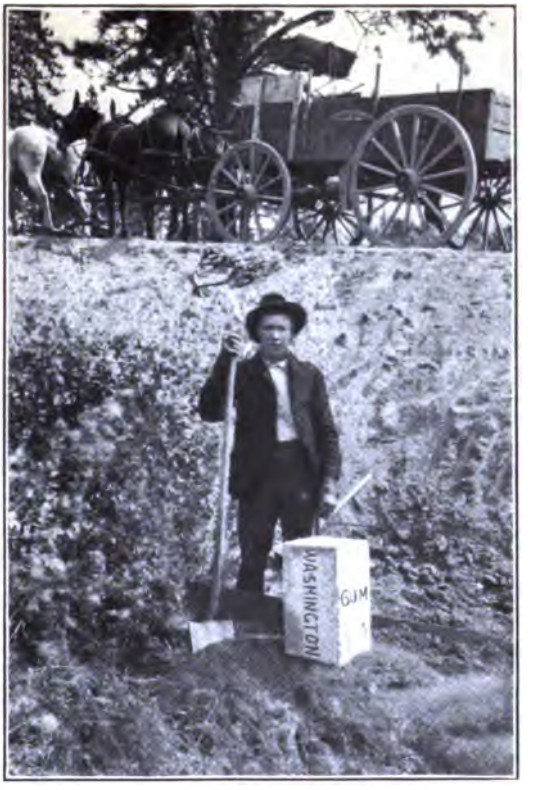
47. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 47 M.", set 3 feet in ground, with pits 2 feet deep, 6 feet north and 6 feet south. Butt of rotted square pine post was found in ground under fence, about 5.5 chains southwest of house of J. H. Chandler, 3.83 chains north of corner of fence east.

48. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 48 M.", set 3 feet in ground, with pits 2 feet deep, 6 feet north and 6 feet south. A stone marked "I" on east, "W" on west, and "48" on south was found set in a mound, with pits 6 feet north and 6 feet south. In digging, traces of rotted pine post were found.

49. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 49 M.", set 7 links east of east wagon track of road to replace bottom of old post found in the ground, badly decomposed. A conical mound was built around post 4 feet in diameter and 2 feet high, and pits were dug 6 feet north and 6 feet south of post. Mound and pits for old milepost 49 were found.

50. Granite monument 6 feet long, 1 foot square, with upper 18 inches dressed and 10 inches square, marked "Idaho" on east side, "Washington" on west side, and "50 M." on south side, with brass tablet set in top stamped "1908 50 M." This monument was set to replace old milepost 50, which was found on line 2 feet east of wagon tracks of road. The top had been graded off, but the rotten bottom remained.

51. Iron post 6 feet long, 4 inches in diameter, marked "1908 51 M.", set in old mound which was found on west side of road, with traces of pits. Mound and pits were reshaped. (See Pl. III, *B*, p. 16.)



A. STONE MONUMENT NO. 60.

B. STONE MONUMENT NO. 115.

52. Iron post 6 feet long, 4 inches in diameter, marked "1908 52 M.", set in place of old post, remains of which, with pits, were found on line. The post falls 26 links west of wagon track, 21 links east of west fence, half way down slope toward the south. A mound of earth was built around post and pits dug 6 feet north and 6 feet south.

53. Iron post 6 feet long, 4 inches in diameter, marked "1908 53 M.", set in place of remains of old milepost 53, which was found on a steep graded bank, 6 links east of east wagon track of road. A mound was built around post and pits dug 6 feet north and 6 feet south.

54. Iron post 6 feet long, 4 inches in diameter, marked "1908 54 M.", set in place of remains of old milepost 54, which were found on line, with traces of mound and pits 44 feet west of east fence of wagon road.

55. Granite monument, marked "Idaho" on east side, "55 M." on south side, and "Washington" on west side, with brass tablet set in top stamped "1908 55 M.", set in place of old milepost 55, remains of which were found between wagon tracks and west fence of roadway.

56. Iron post 6 feet long, 4 inches in diameter, marked "1908 56 M.", set in place of rotten bottom of old post, which was found in low mound, with traces of pits, in grainfield, 39 links east of fence. A mound was built of earth around post, but no pits were dug, as the post falls in the grainfield.

57. Iron post 6 feet long, 4 inches in diameter, marked "1908 57 M.", set in place of old milepost 57, remains of which were found 1 link west of fence. A mound was built around post and pits dug 6 feet north and 6 feet south.

58. Iron post 6 feet long, 4 inches in diameter, marked "1908 58 M.", set on east side of road just west of north and south fence, against south side of old milepost 58, a 6 by 6 inch pine post, which was found 1.5 feet above ground, marked "1873" on north side, "58" on south side, "W. T." on west side, and "I. T." on east side. A mound was built around post and pits dug 6 feet north and 6 feet south.

59. Iron post 6 feet long, 4 inches in diameter, marked "1908 59 M.", falls 123 links south of fence that bears west and 15 links east of old fence line, and 45 links east of new fence. A conical mound 2 by 4 feet was built around post and pits dug 6 feet north and 6 feet south. Old milepost 59 was not found, and position was adjusted between found posts 58 and 62.

60. Granite monument 6 feet long, 1 foot square, with top 18 inches dressed, marked "Idaho" on east side, "60 M." on south side, and "Washington" on west side, with brass tablet set in top stamped "1908 60 M." North and south fence bears east 2 links. Post is set at foot of south slope of Chicago, Milwaukee & Puget Sound Railway grade and at foot of west slope of road grade. No trace of old milepost 60 was found, and position was adjusted between found posts 58 and 62. (See Pl. V, *A*.)

61. Iron post 6 feet long, 4 inches in diameter, marked "1908 61 M.", on line, set about 2 feet deep in very rocky soil, with mound of rocks built around post 3 by 3 feet. Pits were dug 6 feet north and 6 feet south of post. No certain evidence of exact position of old milepost 61 was found. Rotten remains of old bearing tree were found 41 links south and 7 links west of position for milepost. Remains were not in place but lying on hillside. A stone was also found 41 links south and 3 links east of position, marked "E1" on top. As the stone would not have marked place of old milepost on account of discrepancy of bearing tree, the new post was set on adjusted distance on true line between posts found.

62. Iron post 6 feet long, 4 inches in diameter, marked "1908 62 M.", set on fence line in place of old post, rotten remains of which were found in low mound, with traces of pits on fence line. Stump of old bearing tree was

found S. 20° W., 1.72 links distant. A mound of earth 4 by 2 feet was built around post and pits were dug 6 feet north and 6 feet south.

63. Iron post 6 feet long, 4 inches in diameter, marked "1908 63 M.", set against south side of old milepost 63, which was found. Post falls 1.5 links west of west fence of road, 9 links west of west track of wagon road, two-thirds way up south slope. A mound 3 by 4 feet was built around post and pits were dug 6 feet north and 6 feet south.

64. Iron post 6 feet long, 4 inches in diameter, marked "1908 64 M.", on north side of fence post on west side of wagon road. The fence post, an extra long one, was set to mark the position of old milepost 64, the remains of which had been found by Mr. Dacknell, who lives on this place, in putting in new fence. No milepost was found between milepost 64 and milepost 67. Milepost 67 falls west 42 links; bearing of true line is N. 6′ W.

65. Granite monument 6 feet long, 1 foot square, with upper 18 inches dressed, inscribed "Idaho" on east side, "65 M." on south side, and "Washington," on west side, with brass tablet inlaid in top, marked "1908 65 M.", on west side of fence. No traces of old milepost 65 were found.

66. Iron post 6 feet long, 4 inches in diameter, marked "1908 66 M.", 33 links east of west fence of road and 10 feet west of west wagon track of road. An earth mound 2 by 4 feet was built around post and pits dug 6 feet north and 6 feet south. No traces of old milepost 66 were found.

67. Iron post 6 feet long, 4 inches in diameter, marked "1908 67 M.", set in place of old milepost 67, the remains of which were found, with evidences of mound and pits, 2 feet east of west fence of road near top of north slope. A mound 2 feet by 4 feet was built around post and pits dug 6 feet north and 6 feet south.

68. Iron post 6 feet long, 4 inches in diameter, marked "1908 68 M.", set close to north side of old basalt stone milepost marked "W. I.", which was found in old mound with traces of two pits on west fence of wagon road. An earth mound 3 feet by 4 feet was built around post and pits 6 feet north and 6 feet south were redug.

69. Iron post 6 feet long, 4 inches in diameter, marked "1908 69 M.", 6 feet west of west fence of road on north side of lane into barnyard near top of north slope of hill. This post was set in place of old stone marked "W. I.", which was found. No traces of mound or pits were found, but in digging remains of old post were found.

70. Granite monument 6 feet long, 1 foot square, upper 18 inches dressed, inscribed "Idaho" on east side, "Washington" on west side, and "70 M." on south side, with bronze tablet set in top marked "1908 70 M." This monument was set in place of stone 6 feet by 12 by 12 inches, which apparently had been set for milepost 70, its position as found agreeing with remains of bearing trees described in old notes. North and south fence bears west 9 links.

71. Iron post 6 feet long, 4 inches in diameter, marked "1908 71 M.", set on north side of old wooden squared milepost 71 which had recently been set on north and south fence line, 9 links west of west track of old wagon road, its position corresponding with bearing trees mentioned in old notes. An earth mound 2 feet by 4 feet was built around iron post, and pits dug 6 feet north and 6 feet south.

72. Iron post 6 feet long, 4 inches in diameter, marked "1908 72 M.", set against north side of old milepost 72, which was found standing 2.5 feet above ground on fence line, marked "W. T." on west side, "I. T." on east side, and "1873" on north side. An earth mound 2 feet by 4 feet was built around iron post, and pits dug 6 feet north and 6 feet south.

73. Iron post 6 feet long, 4 inches in diameter, marked "1908 73 M.", set 3 feet east of fence, where old mound and remains of old milepost 73 were found. An earth mound was built around post, and pits dug 6 feet north and 6 feet south.

74. Iron post 6 feet long, 4 inches in diameter, marked "1908 74 M.", set in place of old milepost 74, remains of which were found with charred block at bottom. The post falls in timber at top of a hill. An earth mound 2 feet by 4 feet was built around post, and pits dug 6 feet north and 6 feet south.

75. Iron post 6 feet long, 4 inches in diameter, marked "1908 75 M.", adjoining old milepost 75 on the north side. The old post was found standing 3 feet above ground, with bearing trees as described in old notes. Post is on fence line in timber. An earth mound 2 feet by 4 feet was built around post, and pits dug 6 feet north and 6 feet south.

76. Post 4 feet long, 4 inches in diameter, marked "1908 76 M.", set in place of old milepost in center of road, the position of which was checked by three bearing trees. In digging hole for new post, bottom of old one was found. New post is set just below the surface of ground. From post, road fence bears west 45 links and east 38 links; small culvert bears south 98 links; line of fence from west bears south 161 links.

77. Iron post 6 feet long, 4 inches in diameter, marked "1908 77 M.", set in center of old abandoned logging road on south slope of small spur, in place of old milepost 77, the position of which was checked by four bearing trees, and the remains of which were found in digging. A stone 3 by 6 by 12 inches was found buried, adjoining position of old post.

78. Iron post 6 feet long, 4 inches in diameter, marked "1908 78 M.", set in place of old milepost 78, which was found on east slope of hill, badly decayed, but marked as described in old notes, and with bearing trees as noted.

79. Iron post 6 feet long, 4 inches in diameter, marked "1908 79 M.", set on west slope of hill in place of old milepost 79, which was found lying on the ground at its original position, checked with bearing trees.

80. Iron post 6 feet long, 4 inches in diameter, marked "1908 80 M.", set on gentle southeast slope of hill in brush and dead timber, adjoining old milepost 80 on the south. The old post was found well preserved and still standing.

81. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 81 M.", set 3 feet in ground in place of old milepost 81, which was found broken off at butt, in open slashing and burn on top of ridge running west to one prong of Liberty Creek, about 1.5 chains west of spring.

82. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 82 M.", set in place of old milepost 82, the rotted pine butt of which was found under State line fence about 8 chains northwest of house of Mrs. Anderson, who owns land on east of line.

83. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 83 M.", set 3 feet in ground. Found a flat sandstone marked "W." on west side and "I." on east side, set in ground below State line fence for old milepost 83. One old bearing tree, a yellow pine 4 feet in diameter, the top of which was dead, was found S. 24° E., 150 links distant.

84. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 84 M.", set 3 feet in ground in place of old milepost 84, the burned butt of which was found under State line fence. Pits 2 feet deep were dug 6 feet north and 6 feet south.

85. Granite monument 6 feet long, dressed 10 inches square on top and on sides for 18 inches down from top, marked "Washington" on west side, "Idaho" on east side, and "85 M." on south side, with brass tablet stamped "1908 85 M.", countersunk and cemented in top. Monument is set 3½ feet in

ground in place of rotted butt of old square pine milepost 85, which was found in edge of cultivated field of Louis Lowentrout, 22 links west of road.

86. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 86 M.", set 3 feet in ground on west side of road and on east side of a cultivated field, in place of old milepost 86, a granite stone marked "I" on east and "W" on west which was found under the State line fence. One old bearing tree, a pine 3½ feet in diameter, bearing N. 28° E., 116 links distant, marked "Idaho B. T.", was found, the other two bearing trees having been cut down.

No trace of Reeves's milepost 87 could be discovered. The point for milepost 87 falls in wagon road with cultivated fields on both sides. The distance between 86 and 88 was found to be 159.38 chains and the falling 131 links to the east. The true bearing is therefore N. 28′ W., and the length of each mile 79.69 chains.

87. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 87 M.", set 3 feet in ground under east fence of State line road and on direct line between mileposts 86 and 88. Pits 2 feet deep were dug 6 feet north and 6 feet south.

88. Granite monument 6½ feet long, dressed 10 inches square on top and for 18 inches down from top on each side, marked "Washington" on west side, "Idaho" on east side, and "88 M." on south side, with brass tablet marked "1908 88 M." countersunk and cemented in top. Monument was set 3½ feet in ground, with mound of rock piled around it, in place of rotted butt of old milepost 88, which was found in mound, with pits north and south, under north and south State line fence, 28 chains north of center of Spokane River, 2.7 chains north of Spokane-Cœur d'Alene road and Washington Water Power Co.'s transmission line, 60 links southwest of curve in irrigation ditch.

89. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 89 M.", set 3 feet in ground, with mound of rocks around post and pits 2 feet deep, 6 feet north and 6 feet south. A pile of rocks was found under fence, and by digging rotted butt of old pine milepost 89 was found.

90. Granite monument 6½ feet long, dressed 10 inches square on top and for 18 inches down from top, marked "Washington" on west side, "Idaho" on east side, and "90 M." on south side, with brass tablet stamped "1908 90 M." countersunk and cemented in center of top. Monument is set 3½ feet in ground one-quarter of a mile south of main line of Northern Pacific Railway, and has mound of rocks piled around it. Old mound was found under fence, with pits north and south, and by digging down in mound rotted butt of old pine milepost 90 was found.

91. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 91 M.", set 3 feet in ground in place of old milepost 91, the rotted pine stump of which was found under State-line fence, 30 links west of wood shack. The old bearing trees were nearly destroyed.

92. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 92 M.", set 3 feet in ground on north side of old pine milepost 92, which was found set in ground and now used as a fence post. Only one of the original bearing trees was found, a yellow pine, 22 inches in diameter, bearing N. 52° W., 90 links distant, marked "Washington B. T."

93. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 93 M.", set 3 feet in ground in place of old milepost 93, the charred top of which was found on ground, and the rotted stump by digging.

94. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 94 M.", 3 feet in ground. An old stone marked "W. T." on west side,

"I. T." on east side, and "94 M." on top was found set in ground, with charred remains of milepost 94 lying on ground beside it.

95. Granite post 6 feet long, dressed 10 inches square on top and for 18 inches down from top, marked "Washington" on west side, "Idaho" on east side, and "95 M." on south side, with brass tablet countersunk and cemented in top, stamped "1908 95 M." Post is set 3 feet in ground, 75 links south of road, on land rising to the north, and is one-half mile south of house of C. F. Lewis. This granite post was set to replace a new pine post 6 inches square, marked "1873" on north side, "95 M." on south side, "I. T." on east side, and "W. T." on west side, which was found projecting 4 feet above ground, with fragments of original old milepost 95 lying beside it.

96. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 96 M.", set 3 feet in ground, in place of a 6-inch pine post, marked "1904" on north, "W. S." on west, "96" on south, and "I. S." on east, which was found projecting 1 foot above ground, with original 10-inch square milepost 96 beside it.

97. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 97 M.", set 3 feet in ground on steep side of ridge facing south, from which can be seen Cœur d'Alene, Newman, Sucker, and Liberty lakes. An old pine post 8 inches square, marked "1904" on north side, "Washington" on west side, "97 M." on south side, and "Idaho" on east side, was found set in ground, with original milepost 97 lying beside it.

98. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 98 M.", set in place of a fir post, 6 inches square, marked "98 M." on south side, "Idaho" on east side, "1904" on north side, and "Washington" on west side, which was found set on a true line, with original milepost 98, marked "1873—I. T.—98—W. T.", lying beside it.

99. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 99 M.", set 3 feet in ground by the side of a white fir post 6 inches square, marked "1904" on north side, "Idaho" on east side, "99 M." on south side, and "Washington" on west side, which was found set in ground, with 3 feet projecting above ground. Four old bearing trees were also found. This post stands on a steep hillside facing north and east, elevation about 4,030 feet.

100. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 100 M.", set 3 feet in ground, just south of small branch of Fish Creek, at an elevation of approximately 3,530 feet. This iron post was set in place of a 12-inch cedar post marked "100 M." on south south side, "Idaho" on east side, "1904" on north side, and "Washington" on west side, which was found with old cedar milepost alongside it marked on south "1873." Two old bearing trees were found.

101. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 101 M.", set 2 feet in ground, resting on bedrock, with mound of rock built around it. This iron post was set in place of a granite block 6 by 8 by 20 inches, marked "101 M." on top, "W." on west side, and "I." on east side, which was found set in mound of rocks on steep ridge, sloping to Fish Creek Canyon. The post stands on side of a steep hill facing south, about halfway to summit, in comparatively open timber and brush.

102. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 102 M.", set in place of an 8-inch square cedar post marked "1904" on north side, "Idaho" on east side, "102 M." on south side, and "Washington" on west side, which was found set in ground with 4 feet projecting above ground, and with original milepost 102, a cedar post 8 inches in diameter, 7 feet

long, marked "1873–I. T.–102–W. T.", lying beside it. This post is on north slope of steep ridge, elevation about 3,500 feet.

103. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 103 M.", set 3 feet in ground on south side of a cedar post 10 inches square, marked "1904" on north side, "Idaho" on east side, "103 M." on south side, and "Washington" on west side, which was found projecting 6 feet above ground, with old fir milepost 103, 10 inches square, marked "1873–I. T. 103 W. T.", lying beside it. This post is on point of ridge between two draws which join about 1.5 chains north and is 9.4 chains south of Spirit Creek.

104. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 104 M.", set 3 feet in ground, on south side of cedar post 10 inches square, marked "1904" on north side, "Idaho" on east side, "104 M." on south side, and "Washington" on west side, which was found set in ground with 4 feet projecting. Old bearing trees were found. This post is about three-quarters of the way up a heavily timbered ridge and is at an elevation of about 3,740 feet above sea level.

105. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 105 M.", set 3 feet in ground on south side of a hemlock post 6 inches square, marked "1904" on north side, "Idaho" on east side, "105 M." on south side, and "Washington" on west side, which was found set in ground, with 3 feet projecting, with top of original milepost 105, marked "1873" lying beside it. No old bearing trees were standing except a 16-inch hemlock S. 10° E., 30 links distant, marked "105 M., B. T." This post stands on a steep slope to east about 8 chains north of crest of high ridge. It is about 4,500 feet above sea level.

106. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 106 M.", set 3 feet in ground, on rocky land sloping northeast. An old granite stone, marked "W." on west side, "I." on east side, and "106" on top, was found set in ground, and three old bearing trees were found.

107. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 107 M.", set 3 feet in ground beside fir milepost 107, 6 inches square, marked "1904" on north side, "Idaho" on east side, "107 M." on south side, and "Washington" on west side, which was found set in ground, with 5 feet projecting above. Four old bearing trees were found. This milepost stands in open timber on land sloping east.

108. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 108 M.", set 3 feet in ground by side of pine post, 8 inches square, marked "1904" on north side, "Idaho" on east side, "108 M." on south side, and "Washington" on west side, which was found set in ground with 4 feet projecting above. No trace of old milepost of 1873 was found. Milepost 108 stands in a burn at south edge of meadow owned by Mr. Hoffman on Blanchard Creek. Elevation is about 2,340 feet above sea level.

109. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 109 M.", set 3 feet in ground by side of pine post 10 inches square, marked "1904" on north side, "Idaho" on east side, "109 M." on south side, and "Washington" on west side, which was found set in ground with 5 feet projecting. Three old bearing trees were found.

110. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 110 M.", set 3 feet in ground by side of cedar post 8 inches square, marked "1904" on north side, "Idaho" on east side, "110 M." on south side, and "Washington" on west side. Three old bearing trees were found. This post is at head of draw running northeast and full of brush.

111. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 111 M.", set 3 feet in ground by side of pine post 10 inches square, marked

"1904" on north side, "Idaho" on east side, "111 M." on south side, and "Washington" on west side, which was found set in ground, with 5½ feet projecting above, and with fragments of original 1873 milepost 111 lying near. Three old bearing trees were found. This milepost stands on south side of shallow open draw, running east.

112. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 112 M.", set 3 feet in ground by side of post 10 inches square, marked "1904" on north side, "Idaho" on east side, "112 M." on south side, and "Washington" on west side, which was found projecting 4 feet above the ground, with remains of original 1873 milepost 112 lying beside it. The wooden post is used as corner of fences running west and north and stands at edge of brush and timber at southeast corner of level cultivated meadow.

113. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 113 M.", set 3 feet in ground in place of old tamarack milepost 113, marked "W. C. 1873", "W. C. I. T.", "W. C. 113 M.", "W. C. W. T.", which was found lying down. This post is about 3 chains west of the Idaho & Washington Northern Railroad and 5 chains east of a marshy lake 160 acres in extent lying on the Washington side of the line.

114. Iron post 6 feet long, 4 inches in diameter, filled with cement, marked "1908 114 M.", set 3 feet in ground by side of tamarack post 8 inches square, marked "1873" on north side, "I. T." on east side, "114 M." on south side, and "W. T." on west side, which was found set in ground, projecting 5 feet above, and used as fence post. Three old bearing trees were found.

115. Granite monument 6 feet long, dressed 10 inches square on top and for 18 inches on each side down from top, marked "115 M." on south face, "Washington" on west face, and "Idaho" on east face, with circular brass tablet stamped "1908 115 M.", countersunk and cemented in top. (See Pl. V, *B*, p. 26.) This monument is set 3½ feet in ground in place of rotted butt of old tamarack milepost which was found in ground on west side of large clearing, 150 links northwest of a barn. Three old bearing trees were also found.

116. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1908 116 M.", set 3 feet in ground in place of old milepost 116, the rotted butt of which was found in ground. Three old bearing trees were also found.

117. Iron post 6 feet long, 4 inches in diameter, marked "1908 117 M.", adjoining old milepost 117 on the north. Old post found burned off at the bottom. Pits were dug 6 feet north and 6 feet south of post.

118. Iron post 6 feet long, 4 inches in diameter, marked "1908 118 M.", set against west side of old milepost 118, which was found still standing, but charred from forest fires. Pits were dug 6 feet north and 6 feet south. A road bears west 41 links.

119. Iron post 6 feet long, 4 inches in diameter, marked "1908 119 M.", set against north side of old milepost 119, which was found still standing, but decayed at bottom, 4 links east of line. Pits were dug 6 feet north and 6 feet south of post.

120. Granite monument 6 feet long, 1 foot square, dressed 10 inches square on top and for 18 inches down sides, marked "Washington" on west side, "Idaho" on east side, and "120 M." on south side, with bronze cap stamped "1908 120 M." set in top. This monument projects 18 inches above ground, and beside it on the north is old milepost 120, a pine post which was found well preserved and in place on west fence line of road. The monument is set against the east side of straight rail fence on the west side of road, with cleared land on the east and timber on the west. The land slopes slightly toward the north. Center of track of road is due east 32 links. Combination board and barbed-

wire fence is due east 42 links. Pits were dug 6 feet north and 6 feet south of monument.

121. Broken granite monument projecting about 0.30 foot above general surface of ground, marked "Washington" on west, "Idaho" on east, and "121 M." on south side, with bronze cap stamped "1908 121 M." set in top. This post is located in a street in the town of Newport. There were no surface traces of old milepost 121. All bearing trees had been destroyed and stumps uprooted, but evidences of their positions remained from the radiating roots; positions consistent with old notes. A hole was dug in the street at the approximate position, and rotten wood of old post and charred block were found beneath the surface. In this hole the above-described broken granite monument was set, one piece 2½ feet long, 12 inches square in the bottom of hole, and on top of that a second piece 3½ feet long, 12 inches square in the rough, dressed to 10 inches square on top and for 18 inches down sides. This monument is 5.32 chains due east of east rail of the Great Northern Railway spur to mill.

122. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 122 M.", projecting about 3 feet above ground on south shore of Rat Island. Plate II, *B* (p. 14), shows one of the witness trees to this milepost.

123. Stone monument 6 feet long, dressed to 10 inches square on top and for 18 inches down sides, engraved "123 M." on south face, "Idaho" on east face, and "Washington" on west face, with bronze tablet stamped "1909 123 M." set in top. Bearing pits were dug 6 feet north and 6 feet south of monument. Old milepost 123 was found, marked "1873" on north face, "123 M." on south face, "I. T." on east face, and "W. T." on west face. This monument stands on south edge of plateau.

124. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 124 M.", set 4 feet in ground in place where old milepost 124 was found rotted off, but with these marks distinguishable: "124 M." on south side, "W. T." on west side, "I T." on east side, and "1873" on north side. Old bearing trees were found as described in notes of 1873.

125. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 125 M.", set 4 feet in ground in place where old milepost 125 had stood. Old post was found rotted and lying on mound of rock, with bearing trees as described in notes of 1873.

126. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 126 M.", set 4 feet in ground in place where old milepost 126, marked "1873" on north face, "I. T." on east face, "W. T." on west face, and "M. 126" on south face, was found rotted off and lying on ground. Bearing trees were found as described in old notes.

127. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 127 M.", set 4 feet in ground in place where old milepost 127 was found standing, but badly rotted and charred, with no markings discernible.

128. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 128 M.", set in place where old milepost 128 was found rotted off and lying down, marked and witnessed as described in old notes. This milepost stands on east slope of mountain.

129. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 129 M.", set in ground, where old milepost 129 was found standing, marked and witnessed as described in old notes. This post stands on northeast slope of spur.

130. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 130 M.", set in ground in place where old milepost 130 was found standing, marked and witnessed as described in old notes. This post stands 20 links *south* of small creek flowing east.

131. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 131 M.", set in ground in place where old milepost 131 was found standing, marked and witnessed by pits as described in old notes. Post stands on east slope of mountain in dense thicket of young trees.

132. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 W. C. 132 M.", set in place of milepost 132 W. C., which was found standing in good condition marked and witnessed as described in old notes.

133. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 133 M.", set in place of milepost 133, a white pine post 10 by 10 inches, marked "Washington" on west, "133 M. P." on south, and "Idaho" on east faces, which was found standing, evidently reset since 1873. It projected 1½ feet above ground. No new bearing trees had been marked, but old Washington and Idaho bearing trees were found. One old bearing tree was found dead and uprooted.

134. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 134 M.", set in place of old milepost 134, which was found marked and witnessed as described in old notes. This post stands on east slope of hill near summit.

135. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 135 M.", set in place of milepost 135, which had evidently been reset. It was marked "135 M." on south, "Washington" on west, and "Idaho" on east faces. No trace of original post was found, but Washington and Idaho bearing trees were located.

136. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 136 M.", set in place of old milepost 136, which was found rotted off and lying down. Washington bearing tree was found but no traces of others. This post stands on south slope of spur about 75 links from summit.

137. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 137 M.", set in place of old milepost 137, which was found standing marked and witnessed as described in old notes. This post stands on south slope of ridge.

138. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 138 M.", set in place of old milepost 138, which was found standing marked and witnessed as described in old notes. This post stands at the foot of a steep northwest slope in heavy timber.

139. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 139 M.", set in place of old milepost 139, which was found lying down with stump in ground, marked and witnessed as described in old notes. This post stands about half way up south slope of spur.

140. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 140 M.", set in place of old milepost 140, which was found rotted off and placed inside rotten tree stump. The witness trees were all down, but stumps were found, and the place where the post had stood was located from directions and distances as given in old notes. No trace of stump of old post could be found, however. Milepost 140 stands on south edge of a ridge about half way to summit.

141. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 141 M.", set in place of old milepost 141, which was found standing marked and witnessed as described in old notes.

142. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 142 M.", set in ground in position of old milepost 142, the stump of which was located from witness trees as described in old notes. The portion of post above ground could not be found. This post stands on southeast slope of ridge, about 4 chains from foot of hill.

143. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 143 M.", set in place of old milepost 143, which was found marked and witnessed as described in old notes.

144. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 144 M.", set in place where stump of old milepost 144 was found. The portion of old post above ground could not be found, but the old Idaho bearing tree was standing in fair condition. From it the other bearing trees were located, and the stump of the post found.

145. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 145 M.", set in place of old milepost 145 in bottom of gulch.

146. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 146 M.", set in place of old milepost 146, which was found lying on ground with rotten stump in ground.

147. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 147 M.", set in ground in place of old milepost 147, which was found standing in good condition, with bearing trees as described in old notes.

148. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 148 M.", set in place of old milepost 148. The old post was not standing, but from the old bearing trees a charred post, without discernible scribing, was found, and by digging the bottom of the old milepost was located near it.

149. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 149 M.", set in place of old milepost 149, which was found, as were all the old bearing trees, in good condition. Post stands on north slope of mountain in open timber. About 151.5 links east of the old milepost was found an old camp of the party of 1873, with a blazed cedar tree at the camp site, marked "Saturday Camp Oct. 9, 1873."

150. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 150 M.", set in place of old milepost 150, which was found rotted off and lying down, but with all marks in good condition. All old bearing trees were found in good condition. This post stands on nearly level bench land.

151. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 151 M.", set in place of old milepost 151, which was found standing in good condition.

152. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 152 M.", set in place of old milepost 152, which was found standing. The old bearing trees were in good condition.

153. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 153 M.", set in place where old milepost 153 was found, on southern edge of a large burn, land rising gradually toward the north. The old bearing trees were probably destroyed by fire, but the post was in good condition.

154. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 154 M.", set in place where old milepost 154 had stood. Old post was lying on ground, and a new balsam post was found set in hole above stump of old post.

155. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 155 M.", set in place where old milepost 155 was found standing in good condition.

156. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 156 M.", set 3 feet in ground in place where old milepost 156 had stood. Old post, marked "W. T., I. T., 1873, 156," with upper part well preserved, was found rotted off and lying on ground. The bearing trees were as described in old notes. Plate IV (p. 18) shows a section of one of the witness trees.

157. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 157 M.", set 4 feet in ground in place where old milepost 157 had stood.

Old post marked "1873" on north face, "I. T." on east face, "157" on south face, and "W. T." on west face, was found standing and in good condition and was placed beside new iron post. Old yew bearing tree, 16 inches in diameter, marked "Idaho" and at base "B. T.", was found S. 10° E., 12.5 links distant.

158. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 158 M.", set 4 feet in ground at point where old milepost 158 was found, standing, but charred so that no marks were discernible. A pile of rocks was heaped about 6 inches around the old post. Burned-over blaze and scribe marks were found on a bearing tree S. 30° W., 21 links distant.

159. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 159 M.", set 4 feet in ground in place where old milepost 159 was found, standing, in good condition. Old bearing trees were found as described in old notes.

160. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 160 M.", set 4 feet in ground on southeast slope of hill near top of ridge in brush and young hemlock, white pine, and spruce timber, in place where old milepost 160 had stood. The old post was found rotted off and lying down and the place where it had stood was determined from the witness trees, which were all found.

161. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 161 M.", set 4 feet in ground, with rocks piled around base, on south side and against stump of tree found on line. Old milepost 161 was found lying down, apparently never having been set; in the old notes it is described as "a balsam fir 10 inches in diameter on line." Bearing trees were found as described in old notes.

162. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 162 M.", set 3 feet in ground, with rocks piled about 1 foot high around it, in hole where old milepost 162 had stood. Old post was found lying down and rotted, with bearing trees as described in old notes.

163. Iron post 6 feet long, 4 inches in diameter, filled with concrete, marked "1909 163 M.", set 2 feet in ground to solid rock, with rocks piled about 2 feet high around it, in place where old milepost 163 was found, standing, in good condition, witnessed as described in notes of 1873.

164. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 164 M.", set 3 feet in ground in place of old cedar milepost 164, which was found in apparently as good condition as when set, marked and witnessed as described in notes of 1873, at the head of a small gully leading from a lateral table-land about halfway up mountain side, surrounded by rather heavy cedar and hemlock timber.

165. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 165 M.", set 3½ feet in ground in place where stump of old milepost 165 was found in ground, with old post lying beside it, marked and witnessed as described in old notes.

166. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 166 M.", set 3 feet in ground in place where stump of old milepost 166 was found in ground, with upper part of post rotted off and lying down beside it, in good condition, marked and witnessed as described in notes of 1873. This post stands in a narrow valley.

167. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 167 M.", set 3 feet in ground in place where stump of old milepost 167 was found, with upper part rotted off and lying beside it, marked and witnessed as described in notes of 1873.

168. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 168 M.", set 3 feet in ground, in place where old milepost 168 was found standing in good condition, marked and witnessed as described in notes of 1873, on southwest slope of mountain about halfway to the summit.

169. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 169 M.", set in place of old milepost 169, which was found rotted off and lying down beside stump in ground, on steep north slope about 7½ chains south of one branch of Hughes Creek.

170. Sandy quartzite schist rock, 12 inches by 12 inches by 3 feet, with bronze tablet marked "1909 170 M.", inserted in top, set in place of old milepost 170, which was found almost rotted off and leaning on rock uphill, marked and witnessed as described in notes of 1873, on southwest slope of mountain about two-thirds of distance to summit.

171. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 171 M.", set in place of old milepost 171, which had apparently been knocked over by a falling tree, on east slope of a hill in a dense thicket of small trees and brush.

172. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 172 M.", set in place of old milepost 172, which was found lying down and partly rotted. The old bearing trees could not be found.

173. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 173 M.", set 2 feet in ground to bedrock, with rocks piled around post in place of old milepost 173, which was found lying down, rotted, and showing effects of fire, all marks except "W. T.", being obliterated. The old bearing trees could not be found, probably having been destroyed by fire.

174. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 174 M.", 2.3 links north of old milepost 174, a fir tree marked on four sides as described in old notes, still growing and in good condition. All old bearing trees were found in good condition.

175. A quartzite rock 5 feet long and 18 inches square, with brass tablet inserted in top stamped "1909 175 M.", set in hole 2½ feet deep in place of old milepost 175, which was found rotted off and lying down, with all scribing discernible and all old bearing trees in good condition.

176. Iron post 6 feet long, 4 inches in diameter, filled with charcoal, stamped "1909 176 M.", set in place of old milepost 176, the stamp of which was found in ground, with post lying down beside it, rotted and all marks except "1873" obliterated. All old bearing trees were found. Post stands on south slope of mountain, the ridge of which bears nearly north and south.

176½. Stone 3½ feet long, 14 inches wide, and 8 inches thick, with bronze tablet set in top stamped "1909 176½ M.", set 2 feet in shallow ground and rock mound built around it to make it firm, in place where old milepost 176½ was found lying down and rotted, with all old marking still discernible. All old bearing trees were found as described.

This marks the north end of the retracement of the old survey. The line from this point northward to the international boundary was run as an original survey.

177. Iron post 6 feet long, 4 inches in diameter, filled with concrete, stamped "1909 177 M."

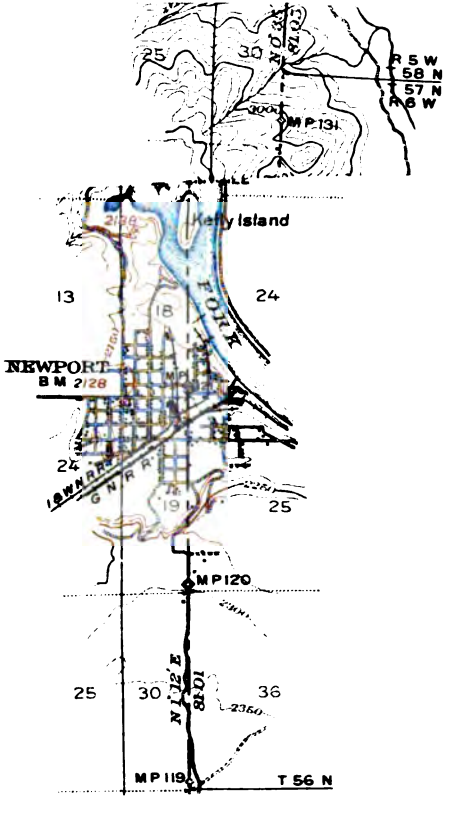
Monument at international boundary: The position of the Canadian line was obtained in the following way. Transit was set up at boundary monument 195, (Pl. VI, *A*), which is on summit of a mountain 13.37 chains east of State line. The monument was sighted 2 miles to the west on the summit of another mountain. With this direction, the line was run westward until the State

A. INTERNATIONAL BOUNDARY MONUMENT NO. 195.

B. MONUMENT AT INTERSECTION OF IDAHO-WASHINGTON BOUNDARY LINE WITH INTERNATIONAL BOUNDARY.

line was intersected. A point 0.53 link south of intersection, on account of curvature of parallel, was accepted as true intersection. The direction of the line connecting the two international monuments was found to be S. 89° 42′ W. At point of intersection, a pit 3 feet square and 2 feet deep was dug, and a monument built in it of quartzite rock with cement mortar, 6 feet high, 4 feet above ground, tapering from 3 feet square at the base to 1 foot square at the top, with a bronze tablet stamped "1909-Canada-United States-Washington-Idaho", inserted in top. (See Pl. VI, *B*.) Elevation of international monument 195 is 6,153.93 feet, elevation of State monument 6,027.10 feet; these elevations are not checked and are on vertical angle stadia line 30 miles from the bench mark.

O



Line Retracement	S. S. Gannett, Geographer.	Miles 1-2, 17-49, 81-116
	C. L. Nelson, Topographer.	Miles 3-16, 50-80, 117-128, 143-177.6
	S. G. Lunde, Jr., Topographer.	Miles 129-144
Topography	C. L. Nelson, Topographer.	Miles 1-5, 109-128, 144-177.6
	Bayard Knock, Field Asst.	[illegible]

MAP OF
RETRACEMENT
OF THE
IDAHO-WASHINGTON BOUNDARY LINE
WITH
REESTABLISHED MONUMENTS

FROM THE JUNCTION OF THE SNAKE AND CLEARWATER RIVERS
NORTHWARD TO THE INTERNATIONAL BOUNDARY AS SURVEYED
AND MARKED BY THE

UNITED STATES GEOLOGICAL SURVEY

in 1908-9

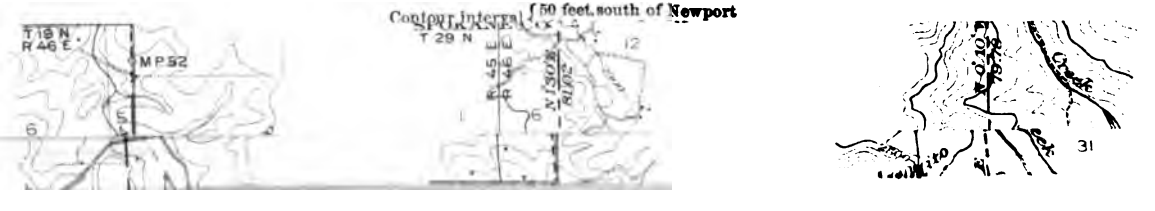
under Act of Congress approved May 27, 1908

Scale $\frac{1}{62500}$

1 $\frac{1}{2}$ 0 1 2 3 Miles

1 $\frac{1}{2}$ 0 1 2 3 Kilometers

Contour interval 50 feet south of Newport



U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIR.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

BULLETIN 467

GEOLOGY AND MINERAL RESOURCES

OF PARTS OF THE

ALASKA PENINSULA

BY

WALLACE W. ATWOOD

WASHINGTON
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PREFACE.

By Alfred H. Brooks.

During the Russian occupation of Alaska many facts concerning the geology of Alaska Peninsula were collected, but Dall and Becker's study of the coal and gold deposits of Unga Island and of some of the coal beds of the mainland in 1895 represents the first attempt at systematic investigation of the mineral resources. Martin, in 1903 and 1904, made the first examination of the petroleum seepages. Meanwhile other investigators had contributed to the knowledge of the general geology, the most notable work being Martin and Stanton's summary of the Mesozoic stratigraphy.

The pursuance of the general plan of investigating the coal resources of Alaska led to the surveys here reported. Mr. Atwood's chief purpose was to survey the three most important local coal fields, the Chignik, Herendeen Bay, and Unga, but incidentally he collected considerable information in regard to the general geology and mineral resources of the entire peninsula. The data thus gathered, together with the results of previous investigations, have been embodied in this report.

Mapping was done in some detail in the surveyed coal fields and the results are set forth with considerable confidence as to their accuracy. Far less definite information was obtained as to the areal and stratigraphic geology and mineral deposits of the rest of the peninsula. Therefore the sections devoted to these subjects must be regarded simply as a summary of the best information available. It is believed, however, that this report will serve as a useful reference book both to those who are developing the mineral resources of the peninsula and to those who are interested in the more purely scientific problems. If funds are available, more detailed investigations of the geology and mineral deposits will be undertaken when the mining advancement seems to demand them.

The discovery of gold in California and the consequent increase in the population of that State led to a demand for fuel along the Pacific seaboard, and this demand provided the first incentive to the search for coal in Alaska. As early as 1854 attempts were made to mine coal on Cook Inlet. Coal claims were staked on Unga Island

in the early seventies and 10 years later some systematic mining at this and other localities in southwestern Alaska was begun. The rapid development of the more accessible coal fields of California, Washington, and Vancouver Island, which began about 1870, supplied the west coast market, and from that time until very recently little attention has been given to Alaska coal. Mining to supply local demand has, however, continued in the peninsula to the present day.

The coal of Alaska Peninsula is not of as high grade as that of the Bering River and Matanuska fields, but the fields are more accessible. The fields here described are all near good harbors, a location that will give them an advantage over the higher-grade coals of other Alaska fields. Moreover, their close proximity to the great circle route from Puget Sound to Yokohama will certainly eventually accrue to their benefit, though it must be confessed that their immediate use for trans-Pacific shipment does not seem practicable. On the other hand, unless petroleum is found, they furnish the only local source of fuel for Alaska Peninsula, which is without timber.

Some drilling for oil has been done on the peninsula, but it has not shown either the presence or the absence of a commercially valuable pool. It appears, however, that the geologic data at hand warrant the continuation of the search.

So far as known geologic conditions like those on Unga Island, where successful gold mining has been carried on for many years, may be found in other parts of the Province, so that there seems to be a field here that warrants the attention of the lode prospector.

Except for the absence of timber, the conditions in Alaska Peninsula are more favorable for mining than in many other parts of the Territory. The open season is longer and the winter is less severe than in the interior or in Seward Peninsula. Numerous good harbors are open to navigation throughout the year. The luxuriant growth of grass in the peninsula, except in the high mountains, favors the use of horses, and the many streams and lakes render much of the region readily accessible to small boats.

GEOLOGY AND MINERAL RESOURCES OF PARTS OF THE ALASKA PENINSULA.

By WALLACE W. ATWOOD.

INTRODUCTION.

LOCATION AND EXTENT OF AREA CONSIDERED.

The regions under consideration in this report are included within that portion of Alaska that extends southwestward from Cook Inlet to Unimak Pass. This land area is a relatively narrow peninsula, tapering from a width of about 100 miles at the northeast end to about 20 miles at the southwest end. (See Pl. I.)

A line drawn from Cape Douglas to the head of Bristol Bay may be taken as the northeast limit of the peninsula. The western limit, strictly defined, is at the margin of the land just east of Unimak Island. The water route between Unimak Island and the true end of the peninsula is, however, narrow and very shallow, being unnavigable except by small boats, and since the physiographic break is so slight the peninsula has been here defined, for convenience in description, as extending to the western margin of Unimak Island or to Unimak Pass. This land is included between 54° and 59° north latitude and 153° and 165° west longitude. The linear extent of the peninsula from northeast to southwest is approximately 550 miles; the areal extent is fully 30,000 square miles. Numerous islands, some of which will be referred to in this report, are associated with the peninsula. The total land area of these islands, not including the Kodiak group, is probably about 4,000 square miles.

PREVIOUS EXPLORATIONS AND SURVEYS.

Early explorations.—Previous to 1741 southwestern Alaska had not been visited by white people. In that year Vitus Bering, a Dane commissioned in the Russian Navy, left the coast of Kamchatka in command of an expedition to search for a continent to the east. The expedition sailed in two vessels, one commanded by Bering himself and the other by his lieutenant, Chirikof. The vessels soon became separated, and Bering, after following a very irregular course, reached

the American coast near Mount St. Elias. On his return journey westward he discovered the Shumagin group of islands, among which he remained several days, and passed along the coast to the westward within sight of several of the Aleutian Islands. Chirikof sailed east and sighted the American coast, probably near Cross Sound. He, like Bering, sighted some of the Aleutian Islands on his return journey. During the following half century hardy Siberian fur hunters, called promyshleniki, ventured into these unknown seas in search of valuable furs, the existence of which had been reported by the members of Bering's crew. These daring men pushed their way eastward along the Aleutian chain of islands to the mainland of Alaska, and their ultimate mastery of the region led to Russia's becoming a North American power.

About 1767 Capt. Krenitzin, of the Russian Navy, was sent out to explore the American coast. He determined astronomically a few positions in the eastern part of the Aleutian chain of islands and along the southern coast of the Alaska Peninsula.

The first important systematic survey of any part of what is now known as Alaska was made by Capt. Cook, the great English navigator. He made a landing in May, 1778, near Mount Edgecumbe, in southeastern Alaska, after which he sailed westward, exploring Prince William Sound and Cook Inlet, and thence southwestward along the southern shore of the Alaska Peninsula as far as Unalaska Island. Cook next entered Bering Sea and continued exploration along the coast toward the north, through Bristol Bay, Norton Sound, and Bering Strait, until he was checked by an Arctic ice pack.

In 1789 Joseph Billings left Kamchatka in command of a Russian expedition, with orders to explore and map the coast visited by the fur hunters. He stopped at Unalaska and Kodiak on his way eastward to Prince William Sound, but contributed very little information regarding the geography of southwestern Alaska.

A more valuable series of coastal explorations was undertaken in 1826, and in the next few years a careful survey of the northern coast of the Alaska Peninsula was made by Capt. Lütke. The southern coast of the Alaska Peninsula was mapped about this time by Vasilief. These expeditions were under the auspices of the Russian Government, and their work was the last exploratory work of importance in southwestern Alaska previous to the transfer of that land to the United States.

In 1848 Grewingk[1] compiled an admirable summary of all previous work of a geographic or geologic nature and assembled the facts con-

[1] Grewingk, C., Beiträge zur Kenntniss der orographischen und geognostischen Beschaffenheit der Nordwest Küste Amerikas, mit den anliegenden Inseln, St. Petersburg, 1850. Contains geologic and other maps.

U. S.

veniently in a single volume. Some noteworthy contributions to the paleontology of the peninsula were made by European scientists on the basis of specimens collected by Russians.

For some years after the purchase of Alaska by the United States, in 1867, little exploration work was done, though the Coast Survey began to chart the coast line. In the course of this work, Dall made valuable geologic observations. The first systematic geologic work in the Alaska Peninsula was undertaken in 1895 by Dall[1] and Becker.[2] Dall was authorized by the United States Geological Survey to investigate and report on the coal and lignite deposits of Alaska, and these studies took him to southwestern Alaska. He visited the island of Unga, the coal fields near Herendeen and Chignik bays, and several other points, collecting in addition to all available data on the coal deposits much valuable information on the general geology of the peninsula. Becker at the same time visited southwestern Alaska and reported on the gold mines then in operation on Unga Island.

Late in the season of 1898, Spurr and Post,[3] under the auspices of the United States Geological Survey, crossed the peninsula from Naknek to Katmai. Spurr later prepared a reconnaissance geologic map of that portion of the peninsula based upon that work.

Emerson and Palache,[4] who were members of the Harriman Alaska expedition of 1899, landed at several points on the Alaska Peninsula and neighboring islands, and made important contributions to the knowledge of the general geology of this district. Palache's studies on the shores of Stepovak Bay have been especially valuable to the writer in connection with recent work in that region.

In 1903 Martin[5] examined oil fields near Cold Bay, and in his report refers to the general geology of that portion of the peninsula. T. W. Stanton, G. C. Martin, and R. W. Stone, as members of a United States Geological Survey party, spent the season of 1904 along the shores of the Alaska Peninsula between Cook Inlet and Unga. Their studies were devoted largely to the Mesozoic section[6] and the coal deposits[7] of the peninsula. Unpublished notes and maps by Stone on the Cape Douglas region have been used in the preparation of this report. During the course of the same work Martin visited the Shumagin Islands, and reported upon the gold

[1] Dall, W. H., Report on coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, p. 807.

[2] Becker, G. F., Reconnaissance of the gold fields of southern Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 83-85.

[3] Spurr, J. E., A reconnaissance in southwestern Alaska in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, pp. 43-263.

[4] Emerson and Palache, Harriman Alaska Expedition, vol. 4, 1904.

[5] Martin, G. C., The petroleum fields of Pacific coast of Alaska: Bull. U. S. Geol. Survey No. 250, 1905.

[6] Stanton, T. W., and Martin, G. C., The Mesozoic section on Cook Inlet and Alaska Peninsula: Bull. Geol. Soc. America, vol. 16, 1905.

[7] Stone, R. W., Coal resources of southwestern Alaska: Bull. U. S. Geol. Survey No. 259, 1905, pp. 151-171.

deposits of Unga and Popof Islands.[1] A. J. Collier[2] in 1904 examined the gold-bearing quartz veins on Unalaska Island. In the same year Sidney Paige[3] visited the Herendeen Bay coal field and prepared a report, which appeared in 1906.

The present report is based chiefly upon work during the season of 1908 by the writer, assisted by H. M. Eakin. The studies which had preceded our work aided us in locating points of special interest and in anticipating the general geologic conditions to be dealt with. The results of these earlier expeditions have been freely used in describing the general geologic conditions on the peninsula. During the season Mr. Eakin completed a reconnaissance topographic map of a portion of the peninsula in the vicinity of Balboa and Herendeen bays, including the island of Unga (Pl. II), and later prepared a similar map for the region adjoining Chignik Bay (Pl. VII, p. 40). During the same period the writer prepared a geologic map of each region that was surveyed topographically, and the field work placed on sketch maps has been transferred to the topographic maps with as much accuracy as possible (Pls. VII and VIII, pp. 40 and 42). In addition to the districts in which detailed work was done during the season, a few other points of especial interest were visited, and mention of these points will appear in the course of the report.

ACKNOWLEDGMENTS.

The writer wishes to acknowledge his indebtedness to Messrs. Stanton, Knowlton, and Dall, of the Geological Survey, for their prompt reports on the paleontological material which was brought in from this region and for the cordial conferences through which they have assisted in completing these studies. The writer is also indebted to Adolph Knopf for a petrographic study of certain rock specimens obtained in this field. Mr. Eakin was a most efficient and loyal assistant throughout the season.

Life in this part of Alaska was made especially pleasant at times by the cordial hospitality of Mr. C. A. Fletcher, superintendent of the Apollo mine at Unga, and by the respect accorded our party at the Herendeen Bay coal camp, at Coal Harbor, and at other settlements in that region. In the Chignik Bay field we were most cordially and helpfully assisted by Mr. G. M. Landsberg, superintendent at one of the salmon canneries. Through his kind offices we were enabled to visit many points that we could not otherwise have reached and to prosecute our work with greater ease and safety than we could have provided. The officers of the steamship *Dora* accommodated our party as well as could be expected, and facilitated our

[1] Martin, G. C., Gold deposits of the Shumagin Islands: Bull. U. S. Geol. Survey No. 259, 1905, pp. 100-101.

[2] Collier, A. J., Auriferous quartz veins on Unalaska Island: Bull. U. S. Geol. Survey No. 259, 1905.

[3] Paige, Sidney, The Herendeen Bay coal field: Bull. U. S. Geol. Survey No. 284, 1906, pp. 101-108.

A. VOLCANIC PEAKS ON WEST SHORE OF PAVLOF BAY, ALASKA PENINSULA.

See page 13.

B. CATHEDRAL PEAK, ONE OF THE HIGHER SUMMITS IN THE ALEUTIAN RANGE NEAR BALBOA BAY.

See pages 13, 63.

A. MOUNTAINS AND GLACIERS WEST OF CAPE DOUGLAS.

Mount Douglas, the highest peak in the picture, is about 7,000 feet above sea level. See page 13.

B. VIEW OF CAPE DOUGLAS FROM THE WEST.

The outer portion was an island which has been tied to the mainland by a sand bar. See pages 75, 93.

movements whenever it was possible. Since leaving the field the writer has become indebted to Messrs. F. R. Philbrick and R. A. Foster, engineers at the Herendeen Bay mines, for maps, charts, drill records, and numerous photographs, all pertaining to the Herendeen Bay coal field.

CHARACTER OF THE COUNTRY.

GEOGRAPHY.

MOUNTAINS.

A chain of mountains known as the Aleutian Range runs through the central portion of the Alaska Peninsula. To the northeast these mountains reach elevations of approximately 5,000 feet above sea level; to the southwest they decline gradually to between 2,000 feet and 3,000 feet in the neighborhood of Chignik and Herendeen Bays. Still farther west the general crest line of the range declines, but there are isolated volcanic peaks of conspicuous elevation (Pl. III, *A*). The Aleutian Range has the rugged features characteristic of most young mountains, a condition which, together with the perennial snow fields on the upper slopes, makes the range one of striking scenic beauty (Pl. III, *B*). The peaks are sharply defined, the valleys broad, open, and U-shaped, and the intervalley ridges in most places narrow. Along the summits in the northern portion of the peninsula are several large alpine glaciers. West of Cape Douglas a few glaciers reach nearly to sea level (Pl. IV, *A*), and one glacier on the west slope of Pavlof Mountain is fully 10 miles long. To the southwest, in and near the crest line of the range, large, open, amphitheatral basins have been excavated by the glaciers that formerly existed there. These basins have the characteristic cirquelike form, with rather even floors bounded by precipitous walls.

The lower 300 or 400 feet of the mountain slopes are clothed with grasses, mosses, and irregularly scattered bunches of alder bushes. Above this zone, where the mountain slopes are not too steep for vegetation, they are imperfectly covered by mosses and short grass. In this latter zone, and extending even higher, there is commonly an abundance of dwarfed flowering plants. Still higher, there is a marked areal increase in bare rock surfaces.

On the west shore of Pavlof Bay there are two conspicuous cones (Pl. III, *A*), the larger of which is appropriately known in that vicinity as Smoking Mountain. This peak rises to an elevation of 8,900 feet. On Unimak Island, Shishaldin, Pogromni (6,500 feet), and Isanotski peaks (8,032 and 8,088 feet) are conspicuous volcanic mountains. The mountains of the islands south of the Alaska Peninsula are rugged and reach in some places elevations of about 2,500 feet.

LOWLANDS.

A lowland of varying width extends northwest from the Aleutian Range to the shores of Bristol Bay. Its greatest width is about 20 miles. This lowland belt is continuous from the northeast terminus of the peninsula to a point not far west of Pavlof Bay, or within about 50 miles of the eastern end of Unimak Island. The topography of this lowland belt is that of a plain varied by low morainic hills and narrow valleys. It is a tundralike country, covered with a luxuriant growth of grasses and mosses. Among the morainic hills are shallow depressions containing lakes or marshes.

Most of the larger valleys in the peninsula have bottom lands, nearly at sea level. At the heads of all the larger bays where detailed mapping has been done are extensive meadowlands. These lowland areas, whether in the larger valleys or at the heads of bays, support a growth of grass which in places reaches a height of 5 feet. On the islands where detailed work has been done there are also small lowland areas associated with the larger valleys or marginal portions of the lands. The northwest portion of Unga Island has a gently rolling topography, the highest point being not more than 600 feet above the sea.

COASTS.

The Pacific Ocean side of the Alaska Peninsula presents a bold, rugged shore line, bordered at many points by steep cliffs (Pl. V). It is indented by fiordlike inlets, separated from each other by rocky headlands. The islands bordering the coast appear, in places, to be seaward continuations of the headlands. Along this coast and associated with the steep cliffs are overhanging ledges, arched rocks, sea caves, rock pillars, and balanced rocks—features such as are developed on rock-bound coasts exposed to the vigorous action of ocean waves (Pls. IX, *B*, p. 62, and XII, *A*, p. 92). At several places along this southeast coast of the peninsula are sea terraces, in part cut in solid rock and in part composed of loose material that has been handled by the waves and the undertow. These sea terraces indicate that the sea once stood at a higher level relative to the land.

The northwest coast, bordering Bristol Bay, is in striking contrast to that bordering the Pacific Ocean. From a point near the head of Bristol Bay southwest to within a few miles of the western terminus of the peninsula the coast line is low. It is the margin of the northwest coastal plain of the peninsula and marks the line to which the waters reach, as they lap upon a plain which extends from the base of the mountains seaward and somewhat beyond the present shore line. Low sand bars and islands border the coast on this side of the peninsula, shutting in shallow lakes and lagoons. Sand dunes, some of which are 50 feet in height, are found on the islands and at places

on the mainland. Near the head of Bristol Bay the northwest margin of the peninsula is marked by a low sea cliff, developed by the work of the waves as they have encroached upon the lowland belt.

DRAINAGE.

As the peninsula is narrow, all the streams are short. The main divide is near the crest line of the Aleutian Range and part of the drainage goes to the Pacific Ocean and part to Bristol Bay. The streams emptying into the Pacific Ocean flow through canyonlike valleys until they reach the meadowlands at the heads of bays or fiords. On the northwest or Bristol Bay side, the drainage is delayed in many places in small lakes or ponds. Near the northeast end of the peninsula, among the mountains, are four large lakes—Kukaklek, Naknek, Becharof, and Ugashik—all of which receive their waters from the surrounding mountains and drain westward into Bristol Bay. A chain of lakes extends well into the mountains from the head of Chignik Bay, and from the northern end of this drainage area it is but a short portage over a lowland area to the drainage which flows into Bristol Bay. The route is commonly followed by natives with small boats.

CLIMATE.

The Alaska Peninsula is in about the same latitude as the British Isles, and except in the northern part does not suffer from severe climatic conditions. The rainfall varies from about 100 inches annually in the western portion of the peninsula to probably about 20 inches on the shores of Shelikof Strait. At Coal Harbor (Unga Island) the average annual rainfall is 49 inches. Snow covers the entire area during the winter months, even to sea level, and remains until late in March. By the latter part of May the snows have commonly left the lowlands and the lower portions of the mountain slopes. During the summer months, from June to September, inclusive, much of the weather is delightful. Though rains may be frequent, they are usually not so heavy as to interfere with out-of-door work. The mean temperature from May to October varies from 49.1° at Kodiak, to 45.5° at points farther west.

Weather records made by volunteer observers in southwestern Alaska.[a]

Month.	Kodiak (length of record, 23 months).					Coal Harbor (length of record, 12 years, 2 months).				Unalaska (length of record, 4 years, 10 months).				
	Temperature (°F.).			Precipitation.		Temperature (°F.).		Precipitation.		Temperature (°F.).			Precipitation.	
	Maximum.	Minimum.	Mean.	Mean number of days with 0.01 inch or more.	Mean total (inches).	Maximum.	Minimum.	Mean number of days with 0.01 inch or more.	Mean total (inches).	Maximum.	Minimum.	Mean.	Mean number of days with 0.01 inch or more.	Mean total (inches).
January	51	− 1	30.0	16	4.82	47	− 9	14.0	3.96	52	16	30.0	26.8	17.94
February	52	−10	28.2	14	4.44	51	−12	13.0	4.23	51	9	31.9	21.0	9.82
March	64	11	32.6	11	4.17	53	−11	14.0	4.26	51	5	30.4	22.2	7.76
April	61	20	36.3	14	2.92	65	4	13.2	5.12	59	18	35.6	24.8	9.69
May	62	20	43.2	14	4.97	67	12	11.8	2.49	60	24	40.9	17.2	5.20
June	76	34	49.5	9	2.11	71	15	10.4	2.49	68	34	46.3	11.2	4.94
July	82	40	54.7	7	.80	79	37	10.6	2.81	78	37	50.6	14.8	2.97
August	75	41	55.2	10	2.37	75	33	13.6	3.74	78	36	51.9	15.2	3.39
September	68	36	50.0	12	1.95	72	10	15.9	4.58	68	33	45.5	23.2	9.85
October	59	30	42.3	18	6.31	60	15	16.4	5.33	62	26	37.6	26.4	14.58
November	53	15	34.7	18	6.52	59	14	14.4	5.51	54	19	33.6	23.4	10.95
December	50	− 6	30.5	18	5.72	50	− 2	13.8	4.31	50	12	30.1	24.6	33.99
Year	.....	.....	40.6	161	47.10	.....	.....	161.1	48.83	.....	.....	38.7	250.8	111.08

[a] Taken in part from climatological table by Cleveland Abbe, jr. (Prof. Paper U. S. Geol. Survey No. 45, 1906, pp. 158–170).

Weather record for Mine Harbor, Herendeen Bay, Alaska.

[Records made by volunteer weather observers.]

Months.	Temperature (°F.).					Precipitation.				
	Maximum.	Minimum.	Mean.			Clear.	Clouds, rain, or snow.	Rain.	Snow.	
			Maximum.	Minimum.	Mean.				Maximum.	Minimum.
1902.						*Days.*	*Days.*	*Inches.*	*Inches.*	*Inches.*
October	55	23	45.0	33.6	39.8	7	24	6.15	2	.....
November	47	12	38.9	28.2	34.3	5	25	6.45	8	.....
December	45	− 7	25.7	14.0	20.7	7	24	.89	12	.....
1903.										
January	38	−15	22.7	6.8	13.9	10	21	2.36	9	.....
February	44	−17	34.5	21.1	27.8	5	23	6.61	10	.....
March	49	15	39.2	23.6	31.4	11	20	1.00	3	.....
April	45	15	38.5	26.2	32.4	5	25	2.25	2	.....
May	53	30	45.6	33.6	39.6	6	25	2.59	.....	.....
June	65	32	54.1	40.4	47.3	5	25	1.01	.....	.....
July	68	38	55.6	45.2	50.4	4	27	2.51	.....	.....
August	68	40	57.4	45.8	51.6	5	26	4.25	.....	.....
September	61	31	52.5	42.3	47.4	2	28	5.10	.....	.....
October	55	18	42.9	30.3	36.6	2	29	3.97	.....	.....
November	40	15	33.7	23.8	28.8	2	28	2.60	24	8
December	43	13	34.5	25.5	30.0	4	27	5.92	17	2
	.....	.....	42.6	30.4	36.5	61	304	40.17	.....	.....
1904.										
January	40	− 2	30.1	17.3	23.7	7	24	3.00	18	10
February	41	− 7	28.8	13.1	21.5	8	21	.49	17	10
March	44	4	31.9	15.8	23.9	6	25	.30	15	6
April	45	3	34.0	21.4	27.7	1	29	1.42	20	8
May	55	22	44.7	29.8	37.3	5	26	.81	8	.....
June	58	31	49.5	37.3	43.4	2	28	1.30	.....	.....
July	65	37	53.7	41.6	47.7	1	30	3.79	.....	.....
August	63	30	53.0	43.4	48.1	2	29	4.78	.....	.....

Mine Harbor frozen Dec. 18, 1902, to May 6, 1903; Dec. 29, 1903, to May 26, 1904; Jan. 3 to May 25, 1905; Jan. 15 to Mar. 17, 1906.

Fresh snows are commonly seen on the mountain tops in the later part of August, and preparation for the winter season should not be postponed beyond the last of September. During the winter the snowfall, as reported unofficially, varies from 10 to 30 feet in depth. The mean winter temperature on the Alaska Peninsula is about 30°. The minimum temperatures recorded at the stations where observations have been systematically made are: Kodiak −6°, Coal Harbor −12°, Herendeen Bay −17°. On some of the islands south of the peninsula it is reported that cattle graze throughout the year. During the winter the frequent storms on the Pacific shore are exceedingly dangerous to small craft. Bristol Bay freezes over during the winter and is not usually navigable until late in April.

VEGETATION.

Small conifer trees grow in the northeastern portion of the Alaska Peninsula as herein defined and on Kodiak Island. The trees are fewer in number and smaller in size to the west and disappear altogether in the vicinity of Naknek Lake, where the largest forms of

plant life are alder bushes. These bushes, in places, reach a height of 15 feet, but are more commonly only 6 or 8 feet high. Southwest from Naknek Lake to the end of the peninsula and to the most westerly of the Aleutian Islands there are no trees. The alder bushes are as a rule confined to the lower 500 feet of the mountain slopes and are unevenly distributed. Small willow bushes border some of the streams and grow in the lowland areas. The dominant and conspicuous form of vegetation in this region is grass, which grows luxuriantly in the lowland areas and clothes the mountain slopes, where the surfaces are not too steep or too rugged to permit vegetation to get a footing, to an elevation of about 1,000 feet above sea level. Above the grass-covered areas, even to the tops of the mountains, are occasional small bunches of flowering plants, some patches of short grass, and some moss. The coastal plain on the northwest side of the peninsula is a tundra covered with moss and grass, and mosses and grasses grow luxuriantly over all but the more rugged portions of the islands south of the peninsula. Small areas of land have been cultivated for vegetable gardens at various places in this portion of Alaska, but no more extensive agriculture has as yet been undertaken. The luxuriant growth of grasses in the broad valley bottoms suggests the possibility of raising sufficient winter fodder for cattle, and the grass-covered hillsides would serve as summer ranges.

SETTLEMENT.

Beginning on the northeast the ports at which the United States mail steamer usually calls are Cold Bay, Chignik Bay, Unga (on Unga Island), Sand Point (on Popof Island), Coal Harbor (on Unga Island), Belkofski, Unalaska, and Nushagak. (See Pl. VI, in pocket.) This last port is at the head of Bristol Bay, a little northwest of the peninsula proper, and the mail steamer calls there during the summer months only. At Cold Bay there has been only one white settler during the last few years. At Chignik Bay there are two salmon canneries, a post office, and a native village. During the summer season between 400 and 500 men are employed in the canneries, and a few prospectors are also at work in this region. At Unga there are a post office and a small native village. Some cod fishing is carried on from Unga and at Baralof Harbor, a few miles north of the village of Unga. Sand Point, at the northwest end of Popof Island, is a local trading center and a post office, while Pirate Cove, on the north shore of Popof Island, is a fishing station. At Coal Harbor, on the north end of Unga Island, there is a small settlement of white people. Unalaska is a local trading center and also a coaling station for United States revenue cutters and for steamers engaged in Bering Sea fisheries or trade. Nushagak is an important fishing station, and hundreds of men are engaged during the summer in catching salmon

and in operating the canneries at this port. The winter population, however, consists of scarcely more than a dozen white people and a small number of natives.

A few white people live at a distance from the settlements. At Herendeen Bay, on the north side of the peninsula in about the same longitude as Unga, there is a coal-mining camp, at which there is usually at least one white man. There are white people on the shores of Pavlof Bay, on certain of the islands south of that bay, on some of the Shumagin Islands southeast from Unga, and on Mitrofania Island. In addition to the native villages already mentioned, a few natives live on Bear River, a short distance east of Port Moller, at Port Heiden, Ugashik, Ugaguk, Naknek, and at several other points along the north side of the peninsula. There are small native settlements at the head of Naknek Lake and at Katmai, on the Pacific Ocean side. The entire resident population probably includes not more than 50 whites and 1,000 natives.

COMMERCIAL DEVELOPMENT.

The known mineral resources of the Alaska Peninsula include coal, petroleum, gold, and copper. Their distribution is shown on Plate VI (in pocket). Of the coal fields, only three are known to be of commercial importance—the Unga Island field, the Herendeen Bay field, and the Chignik Bay field.

Unga Island coal field.—Previous to 1882 there was no mining in this field except by Russians, who are reported to have taken some coal from outcrops near the beach. Between 1882 and 1884 a company was engaged in mining at this locality and is said to have kept 20 men at work throughout that period and to have supplied with fuel small steamers engaged in seal hunting. Some of the coal was used for domestic purposes, and two cargoes, amounting to about 700 tons, are reported to have been sent to San Francisco in 1883. The property is now under the control of the Tide Water Consolidated Co. Several drifts have been opened and one mine put into operation on a shipping basis. Bunkers have been built about 100 feet from the shore, and a steel conveyor connects them with the mine. The developed coal bed outcrops about 200 feet above tidewater.

Herendeen Bay coal field.—The presence of coal in the Herendeen Bay region has been known for a number of years. Several attempts have been made toward its development, but little coal has yet been mined. The first exploitation of the field was undertaken in 1880 by a corporation known as the Alaska Mining and Development Co. Two drifts were run, one about 200 feet, the other about 300 feet in length, on a coal bed of 4 feet average thickness. The coal was brought to the water front by a steam motor on a small tramway, and several hundred tons were taken out in 1890, of which amount the U. S. S.

Albatross used between 200 and 300 tons.[1] At that time there was no immediate market for the coal, as the Western States and Territories were fully supplied from the Washington and Vancouver mines. The field was therefore abandoned and no further work was done until 1898, when C. A. Johnson relocated the coal land and started what is known as the Johnson tunnel. The property passed, in 1902, into the hands of a company, which, however, did very little work, and forfeited all its rights in 1904. The present claimants have made surveys of the field and have done some careful prospecting, including a small amount of core-drill work. They have also surveyed a railway route from Herendeen Bay to Balboa Bay and completed a chart of the Balboa Bay Harbor.

Chignik Bay coal field.—Coal was discovered in the bluff of Chignik River in 1885,[2] but active mining was not undertaken until 1893. Since that time the Alaska Packers' Association has operated its mines to procure fuel for the cannery on Chignik lagoon and for the steamers engaged in the fisheries. Short prospecting tunnels have been driven on the coal seams on Whaler's Creek, in Thompson Valley, and a few miles inland from the head of Hook Bay.

Coal developments at other points on the peninsula have been relatively insignificant. On the south side of the peninsula, just east of Pavlof Bay, a little mining of lignite was carried on during the season of 1908 for local consumption. At the other localities where coal is known to exist little more than preliminary prospecting has been done.

Petroleum developments.—Some drilling has been done in the vicinity of Cold and Dry bays, where oil seepages were discovered. In 1902 and 1903 work was carried on at Dry Bay, but the field was afterwards abandoned. In 1903 and 1904 several wells were drilled at Cold Bay, but as they yielded no flow of oil, drilling was discontinued.

Gold.[3]—Placer gold was discovered on Popof Island in the summer of 1904, and it is reported that gold amounting in value to about $12,000 was taken from these beach placers in 1904 and 1905. Little work has been done on this beach since 1905. Four lode claims were staked on the hills immediately adjoining the beach placers in 1908, and on these claims short prospecting tunnels, a few shallow shafts, and one surface crosscut were opened.

Gold-bearing quartz ledges have been found at a number of places on Unga Island. In the southeastern part of the island, about 1 mile from the head of Delarof Harbor and 4 miles from the town of

[1] Dall, W. H., Coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, p. 805.
[2] Idem, p. 802.
[3] More detailed information regarding gold prospects on Popof Island is given on pages 125 and 131 of this report.

Unga, are located the Apollo and Sitka mines. A third mine has been opened on the Shumagin group of claims near the head of Baralof or Squaw Harbor. Several locations for gold lodes have been made on the ridge south of the Apollo mine, in the valley west of the Shumagin mine, and at points about 2 miles south of Coal Harbor.

The Apollo Consolidated mine of Unga Island was on a productive basis from 1891 to 1904, and was reopened during the summer of 1908, when 40 of the 60 stamps in the mill were put into operation and ore that had already been mined was run through the mill. The occurrence of gold at this locality was described by Becker [1] in 1895 and later by Martin,[2] who visited the Apollo mine in 1904 and gathered some additional data.

The Sitka and Shumagin mines have not become productive, and during the season of 1908 no work was done in the Shumagin mine and but little in the Sitka mine. Several gold prospects have been located in the vicinity of Chignik Bay and others near the head of Port Moller, but very little development work has been done at either place.

Copper.—There are no copper mines in southwestern Alaska, but several locations have been made for copper at Prospect Bay and on the east shore of Balboa Bay.

Other resources.—In addition to mineral wealth, the Alaska Peninsula has other important resources. The red fox is most common of the fur-bearing animals of the region, although some Arctic hare are found. Some of the smaller islands south of the Peninsula are used as fox ranches. The brown bear are still somewhat common, and the hides are of some commercial value. Large herds of caribou furnish an abundant supply of fresh meat. Cod fishing stations have been established at several points on the Shumagin Islands and farther west. There are two salmon canneries near Chignik Bay, and others on the north side of the peninsula near the head of Bristol Bay. Several salmon-salting stations have been established along the north shore and each year hundreds of tons of salmon are salted down and shipped to the States at the close of the season. The sea otter that first attracted the Siberian hunters to this coast have become very scarce. During the summer season of 1908 the writer saw three sea otter skins that had been procured by the natives. These three raw skins were valued by fur traders at $700.

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[1] Becker, G. F., Reconnaissance of the gold fields of southern Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 12, 83-85.

[2] Martin, G. C., Gold deposits of the Shumagin Islands: Bull. U. S. Geol. Survey No. 259, 1905, pp. 100-101.

TRANSPORTATION.

At present there is but one regular passenger steamer that visits the ports southwest of Cook Inlet and west of Kodiak. This steamer, which makes one trip a month, connects with regular steamers from Seattle at Seward, and on its westward journey calls at Seldovia and Kodiak before leaving for ports on the peninsula. Private yachts or launches may sometimes be chartered at Seward or Kodiak for the journey west to points on the peninsula or neighboring islands. There is occasionally an opportunity to go direct from Seattle to Dutch Harbor or Unalaska on a steamer bound for Nome, and to make connections at either of those ports for points on the peninsula.

Travel from point to point in the western part of the region is most convenient by means of coasting vessels or other small boats. The large bays, several of which reach well into the central portion of the peninsula, make it possible to go by water to within a few miles of almost any point in the western part of the area. In the northeastern portion the routes of travel are largely determined by the drainage lines, and advantage is usually taken of the large lakes to reach points in this part of the peninsula. It is not difficult to go on foot over the greater part of the peninsula, but a few of the higher peaks are rugged and to climb to their summits would demand some skill. The lower slopes are gentle and their clothing of mosses and grasses helps to make travel over them relatively easy. It would be possible to work with a pack train over much of this country. Horses are now in use over the trail from Balboa to Herendeen Bay, and these horses have traveled over many of the hills in the Herendeen Bay coal field.

There are good harbors at Hook Bay (Pl. XIII, *A*, p. 108), at Anchorage Bay (Pl. XI, *B*, p.86), an arm of Chignik Bay, and in Balboa Bay, near Sand Point. Small harbors are numerous. Prospect Bay, a few miles west of Chignik Bay, offers shelter behind a small hook (fig. 18, p. 129) for a large vessel or for several small boats. Harbor conditions at Unga (Pl. XI, *A*, p. 86) are favorable except during southeast storms. Baralof and Coal harbors, on Unga Island, furnish good shelter and good anchorage. Herendeen Bay may be entered by small ocean-going vessels, and anchorage conditions near the head of the bay are good. Port Moller is so shallow that most of the bottom is exposed at low tide.

The peninsula is often crossed from Portage Bay to Ugashik, part of the route being by water, and may be crossed from Katmai by way of Naknek Lake to Naknek, or from Cold Bay by way of Becharof Lake to Ugaguk. There is a route across the peninsula from the head of Chignik Bay, by way of the Chignik Lakes and a short portage, to the drainage of the north side of the peninsula. The head of Port

Moller is but 8 miles away, and may be reached from a point in Stepovak Bay by a trail leading over a low pass. From the head of Balboa Bay there is a good trail to the head of Herendeen Bay, a distance of 9 miles over a pass about 400 feet above sea level. Unga Island may be crossed in almost any direction on foot. Broad, open valleys make travel from one part of the island to another relatively easy.

GEOLOGY.

GENERAL FEATURES.

AGE AND SUCCESSION OF THE ROCKS.

The geologic history of the Alaska Peninsula, so far as it has been determined, is limited to Mesozoic and Cenozoic times. Some granitic rocks in the northwestern portion of the province are known to be of pre-Upper Jurassic age, but no rocks on the peninsula are definitely known to be pre-Triassic. Since the opening of Mesozoic time sedimentation has been going on in some portion of the peninsula during each of the great geologic epochs, with the possible exception of the Pliocene and the Oligocene. The Triassic is represented in at least one locality. Large areas of Jurassic sediments represent at least portions of the Middle Jurassic and the Upper Jurassic series. The Lower Cretaceous and the Upper Cretaceous are represented. There are also Eocene, possibly some Oligocene, and certainly some Miocene sediments in the province. From the Eocene epoch to the present time there have been numerous volcanic outbursts at various places on the peninsula, and a portion of the material ejected from the volcanoes is possibly of Pliocene age. The Pleistocene or glacial epoch is represented by morainic deposits and some unconsolidated sands, clays, and gravels. Since the close of Pleistocene time there has been an accumulation of alluvial deposits in the valley bottoms, along the shores, and at the heads of the bays.

Sedimentation has not, however, gone on continuously throughout the peninsula from the beginning of the Mesozoic era to the close of the Miocene epoch, nor is it yet known to have gone on continuously during that time in any one portion of the peninsula. The sedimentary record is broken at many places by great unconformities which record periods when this land, or at least a part of it, stood above sea level and was subject to degradation, suffering from the activities of the agents of weathering and erosion just as does the land that rises above the sea level to-day.

The general succession of rocks in the province is shown in the following table:

General section of rocks of the Alaska Peninsula.

System.	Series.	Formation.	Geographic distribution.	Lithologic character.	Thickness.	Remarks.
					Feet.	
Quaternary.	Recent.		Stream valleys and beaches.	Sands, muds, and gravels.		
	Pleistocene.		Lowlands and along valleys.	Unconsolidated clays, sands, gravels, and glacial drift.		
Tertiary.	Pliocene?					
	Post-Miocene.		Unga Island, Popof Island, Balboa Bay, Port Moller, Chignik Bay, Katmai Pass, and west end of peninsula.	Tuffs, agglomerates, breccias, and flows.	1,000+	At places volcanic deposits are accumulating, and near the western end of the peninsula mountains of volcanic origin are not uncommon.
	Miocene.	Unga formation.[a]	Unga and Popof islands, Balboa and Herendeen bays, Port Moller, and near head of Bristol Bay.	Loosely cemented clays, sands, gravels, and conglomerates. Some beds furnish abundant marine fossils.	200+	These deposits usually occur in very small areas.
	Oligocene?					Some of the fossil collections of invertebrates have been determined as possibly Oligocene in age, but the beds from which they were obtained have not been differentiated in mapping from those of Eocene age.
	Eocene.	Kenai formation.[a]	Unga Island, Center of Alaska Peninsula near Balboa Bay, Herendeen Bay, Chignik Bay, near Katmai, and at Cape Douglas.	Shales, sandstones, grits, and conglomerates. Locally carries lignite.	5,000	Carries workable lignite at Coal Harbor. Occupies a very large part of the Alaska Peninsula between Chignik and Pavlof bays.
	Upper Cretaceous.	Chignik formation.[b]	Chignik and Herendeen bays and near Douglas Village.	Conglomerate, sandstone, and shales, with coal seams.	600+	Contains valuable coal beds at Chignik and Herendeen bays.

Cretaceous.	Lower Cretaceous.	Herendeen limestone.[c]	Herendeen Bay to Port Moller.	Arenaceous limestone.	800	
		Staniukovich shale.[d]	Herendeen Bay, Staniukovich Mountain, and east to Port Moller.	Shales and thin beds of sandstone.	1,000+	
Jurassic.	Upper Jurassic.	Naknek formation.[e]	Chignik and Herendeen bays, Naknek Lake, Katmai, Cold Bay, Kamishak Bay.	Sandstone, conglomerate, and arkose.	1,000+	
	Middle Jurassic.	"Enochkin formation."[f]	Cold Bay and Katmai.	Shales and sandstones, with some conglomerate beds.	2,500	
	Lower Jurassic.		Cold Bay?	Shales and sandstones.		"At Cold Bay there are nearly 4,000 feet of shales and sandstones lying between the determined Triassic rocks and the Cadoceras-bearing Enochkin formation, but their exact position in the Jurassic was not determined by paleontologic evidence."[g]
	Lower or Middle Jurassic.		Naknek Lake.	Coarse-grained granitic rocks.		
Triassic.	Upper Triassic.		Cold Bay.	Thin-bedded cherts, limestones, and shales.		

[a] Dall, W. H., Report on coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, p. 836.
[b] New formation name. The type section is exposed in Whalers Creek near Chignik Lagoon.
[c] New formation name. The type section is exposed just east of Mine Harbor, Herendeen Bay.
[d] New formation name. The type section is exposed in Staniukovich Mountain east of Herendeen Bay. The formation is also well exposed in the north wall of Lawrence Valley.
[e] Spurr, J. E., A reconnaissance in southwestern Alaska in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, p. 169.
[f] Martin, G. C., The petroleum fields of the Pacific coast of Alaska: Bull. U. S. Geol. Survey No. 250, 1905, pp. 37–55.
[g] Stanton, T. W., and Martin, G. C., The Mesozoic section on Cook Inlet and Alaska Peninsula: Bull. Geol. Soc. America, vol. 16, 1905, p. 397.

DISTRIBUTION OF FORMATIONS.

The known distribution and the probable extensions of the geologic formations have been indicated on Plate VI (in pocket). In the northeastern part of the peninsula, crossed by Spurr in 1898 and visited along the eastern coast by Stanton, Martin, and Stone during the summer of 1904, the formations include one small area of Triassic rocks, on the eastern shore near Cold Bay, a belt of Middle Jurassic beds, extending from Cold Bay southward along the coast at least as far as Kialagvik Bay, a large area of Upper Jurassic rocks, extending through the central part of the peninsula and outcropping west of Cape Douglas, on the shores of Kamishak Bay, a belt of granite and syenite, bordering the Upper Jurassic belt on the northwest, and, still farther to the northwest and extending to the shores of Bristol Bay, a coastal plain area composed of Quaternary formations. Through the central portion of the peninsula, in the area occupied by the Jurassic formations, there is a belt of recent volcanic rocks. On the eastern coast, north of Katmai, large areas of Tertiary rocks have been located, and Cape Douglas is composed of Tertiary sediments overlain by andesitic lava. Near Douglas Village, on the east coast and a few miles south of Cape Douglas, there is an area of Cretaceous rocks, and the mountains west of Cape Douglas and bordering the coast are composed of granitic rock. At several points between Douglas Village and Katmai recent volcanic rocks are exposed.

Between this northeastern portion of the peninsula and the Chignik Bay region there is an area which has not yet been visited by members of the Geological Survey. The northwest portion, bordering Bristol Bay, is a continuation of the coastal plain area, recognized farther north, and this belt is presumably composed of Quaternary formations. The Middle Jurassic and the Upper Jurassic rocks that appear to the northeast and to the southwest probably form a considerable portion of this intervening unsurveyed area.

The distribution of the formations has been worked out in some detail in the Chignik Bay region. In the axis of the Aleutian Range, northwest of Chignik Bay, there is a belt of Upper Jurassic sediments. This belt is bordered on the north by the Quaternary formations of the northwest lowlands and on the south by a belt of Upper Cretaceous rocks. There are early Tertiary formations overlying the Upper Cretaceous in the area southwest of Chignik Bay. The entire series of sedimentary beds of this region appears to be cut off by a mass of volcanic rocks on the west and the headland northeast of Chignik Bay is composed of recent volcanics.

Between the Chignik Bay region and the area bordering Port Moller and Stepovak Bay the geologic conditions have not been studied in detail. The northern portion is composed of Quaternary formations.

The Pacific Ocean side appears, seen from the vessel, to be made up of recent volcanic rocks, and to judge from the general features seen while coasting along the southern shore, the central portion is composed of a great sedimentary series, probably the eastward continuation of early Tertiary rocks of Chichagof Peak northwest of Stepovak Bay.

The area extending across the peninsula from Port Moller and Herendeen Bay on the north to the shores of Stepovak and Balboa bays, and still farther south to include Unga Island and a small portion of Popof Island, has been studied in some detail. The axis of the Aleutian Range in this portion of the peninsula is composed of early Tertiary formations. Bordering this belt on the north there is a small area in which Upper Jurassic, Lower Cretaceous, Upper Cretaceous, and some Recent volcanics are exposed. Still farther north is the coastal plain belt of Quaternary formations. South of the large area of Tertiary sediments, exposed in the axis of the range, there are irregular areas of Recent volcanic rocks, and at intervals along the coast there are small areas of Tertiary sediments. Within the axial belt of Tertiary, north of Balboa Bay, there are several Recent laccolithic intrusions and numerous dikes and sills.

West of the Balboa-Herendeen Bay district no systematic geologic work has been done. It appears from the general conditions and from such examination as has been made that the belt of Tertiary formations composing the axis of the range north of Balboa Bay continues west at least as far as Pavlof Bay. On the east shore of that bay characteristic early Tertiary fossils were secured. Volcanic features are dominant west of Pavlof Bay. Several volcanoes are active, and so far as known the rest of the peninsula is composed of Recent volcanic rocks.

The islands south and southeast of the Alaska Peninsula, not already mentioned, are composed chiefly of Recent volcanic rocks, although more ancient and more coarsely crystalline igneous rocks are known to occur on some of them.

STRUCTURE.

The general geologic structure of the peninsula is anticlinal, but it is not that of a single anticline throughout the length of the peninsula, nor do the cross sections that have been worked out in detail show a simple anticlinal structure (figs. 1 and 2). The structure of the peninsula is more properly described as that of an anticlinorium.

Faulting has occurred at many places. In some faults the movement along a single plane was as much as 1,000 feet, and in others systems of distributive faults developed, with movements ranging from a few inches to several rods along the separate fault planes. Much of the lava that rose beneath the peninsula during the periods

of volcanism failed to reach the surface. Some of this remained in vertical or nearly vertical fissures as dikes, other masses spread out between sedimentary strata as intrusive sheets or sills, and some entered the sedimentary series as great laccoliths and lifted the overlying beds in large domes.

The sedimentary formations rest in a nearly horizontal position in the northeast portion of the peninsula. As reported by Spurr,[1] there is a slight upturning of the beds on either side of the belt of Recent volcanics through the central portion of this part of the peninsula.

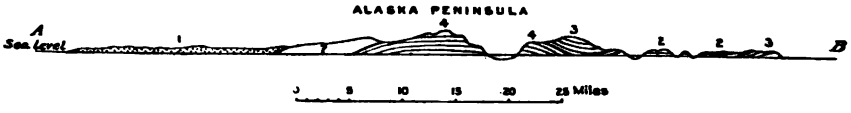

FIGURE 1.—Structure section across the Alaska Peninsula along the line *A–B*, Plate VI (in pocket). 1, Quaternary; 2, Tertiary; 3, Cretaceous; 4, Upper Jurassic.

The coarse-grained crystalline rocks are beneath the Upper Jurassic and overlain by Quaternary formations to the northwest. Stanton and Martin[2] report some open folding along the east coast, with the folds crosscut by an irregular series of faults. A structure section across the peninsula a few miles northeast of Cold Bay would include some Middle Jurassic and Upper Triassic near the Pacific Ocean.

In the Chignik Bay region, the general structure is that of a broad anticlinorium (fig. 1), and this structure continues westward through the Balboa-Herendeen Bay district (fig. 2), to the shores of Pavlof Bay. Bordering the main anticlinal fold in the axis of the range

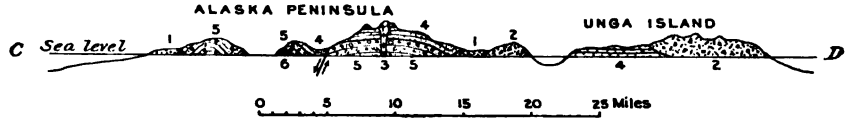

FIGURE 2.—Structure section across the Alaska Peninsula along the line *C–D*, Plate VI (in pocket). 1, Quaternary; 2, volcanic rocks; 3, dacite intrusions; 4, Tertiary; 5, Cretaceous; 6, Upper Jurassic.

are minor folds to the south in the Chignik Bay region and on both the north and south sides in the Balboa-Herendeen Bay region.

On the islands, so far as known, the massive igneous rocks are bordered and at some places covered by basic lava flows and bedded volcanic tuffs. The sedimentary rocks on these islands rest in a horizontal or nearly horizontal position in small areas near the coasts. More detailed descriptions of geologic structures accompanied by other structure sections will be found in other portions of this report.

[1] Spurr, J. E., A reconnaissance in southwestern Alaska in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, p. 146.

[2] Stanton, T. W., and Martin, G. C., The Mesozoic section on Cook Inlet and Alaska Peninsula: Bull. Geol. Soc. America, vol. 16, 1905, p. 393.

STRATIGRAPHY.

Different portions of the peninsula have had geologic histories so different that the structural relations that may be worked out for any one region must necessarily be expected to differ from the structural relations in another part of the province. The geologic successions and stratigraphic relations in different portions of the peninsula are given in the following table:

Geologic succession and stratigraphic relations of rocks in different portions of the Alaska Peninsula.

Northeastern portion of the peninsula.	Chignik Bay region.	Balboa-Herendeen Bay region.	Unga Island.
Glacial drift and recent alluvium.	Glacial drift and recent alluvium.	Glacial drift and recent alluvium.	Glacial drift and recent alluvium.
	Unconformity	*Unconformity*	*Unconformity*
Recent volcanic rocks.	Recent volcanic rocks.	Recent volcanic rocks.	Recent volcanic rocks.
	Unconformity	*Unconformity*	*Unconformity*
		Pliocene?	
		Unconformity	
		Miocene.	Miocene.
		Unconformity	*Conformity*
		Oligocene?	Oligocene?
		Conformity	*Conformity*
Eocene.	Eocene.	Eocene.	Eocene.
Conformity?	*Conformity*	*Conformity*	
Upper Cretaceous.	Upper Cretaceous.	Upper Cretaceous.	
Contact not seen	*Unconformity*	*Unconformity?*	
		Lower Cretaceous.	
		Unconformity?	
Upper Jurassic.	Upper Jurassic.	Upper Jurassic.	
Conformity			
Middle Jurassic.			
Unconformity?			
(Lower Jurassic?)			
Upper Triassic *Base not seen.*			

The base of the Upper Triassic series has not been seen, but it appears that an unconformity exists above the Upper Triassic and below the Middle Jurassic. The presence of the Lower Jurassic is not yet established. The relationship between the Middle Jurassic and Upper Jurassic is probably that of conformity. Between the Upper Jurassic and Lower Cretaceous the relationship has not been satisfactorily determined at any locality. There is probably a somewhat widespread unconformity between the Upper Cretaceous and Lower Cretaceous series, but sedimentation seems to have been continuous from late Cretaceous on into Eocene time, at least in the western part of the peninsula. If the Oligocene is represented at all, it is represented by the upper portion of the great conformable series of beds which includes the Upper Cretaceous and the Eocene. At most places the Miocene rests unconformably upon older formations but on Unga Island it rests conformably upon the upper Eocene. An unconformity separates the rocks of Miocene age from all more recent deposits, and there is likewise an unconformable relationship

between the recent sediments and the deposits of the Pleistocene epoch.

In short, the stratigraphic relations of the rocks of different periods is that of unconformity except where possible Oligocene rests upon Eocene, where Eocene sediments rest upon beds of Upper Cretaceous age, and possibly also in the relationship of the Middle and Upper Jurassic sediments, which may be conformable.

CHARACTER AND DISTRIBUTION OF THE ROCKS.

In this description of the rocks of the peninsula they are taken up in the order of their age, irrespective of sedimentary or igneous origin, beginning with the oldest and continuing to the most recent.

ARGILLITE OF UNKNOWN AGE.

A small patch of argillite is exposed on the east shore of Unga Island between Delarof and Baralof harbors, about 2½ miles northeast of the village of Unga. It is a dense, structureless rock, very brittle, as soft as slate, and without visible crystals. Under the microscope it appears to be of uniform composition, being made up of minute grains, and is of isotropic character. It is exposed in a bold sea cliff composed chiefly of volcanic tuffs that border and overlie it (see fig. 10, p. 70) and is possibly of pre-Tertiary age or older. The overlying tuffs are post-Miocene and probably recent. No similar formation was seen on the island.

TRIASSIC SYSTEM.

The oldest sedimentary rocks exposed in Alaska Peninsula are Upper Triassic. They outcrop near Cape Kekurnoi, at the north entrance of Cold Bay, and extend northeastward several miles.[1] They doubtless underlie the Jurassic throughout the Cold Bay region. The Triassic rocks at this locality consist of thin-bedded chert, limestone, and shale of varied colors. The chert and limestone are usually black, green, or dark red when fresh, but weather to lighter shades. Stanton and Martin estimate the thickness of this series to be at least 2,000 feet, but state that in the exposures visited the base was cut off by intruded igneous rocks. The Triassic rocks are reported to be closely folded, frequently crumpled, and cut by numerous dikes, some of granite, others of andesite and basalt. The igneous rocks were intruded soon after the folding, which must have closely followed Triassic time, for they do not cut younger rocks. The Triassic fauna of the region, as now known, is almost limited to a single species, *Pseudomonotis subcircularis* Gabb, which, however, is very abundant

[1] Stanton, T. W., and Martin, G. C., The Mesozoic section on Cook Inlet and Alaska Peninsula: Bull. Geol. Soc. America, vol. 16, 1905, p. 393.

in certain layers of shale and limestone at Cold Bay. Of this species Stanton and Martin state:

> In California *Pseudomonotis subcircularis* is confined to the Swearinger slates, which form the uppermost Triassic formation in that region. Similar beds with the same fossil occur in Vancouver and Queen Charlotte Islands and on the mainland of British Columbia, and they cover considerable areas in the Copper River region of Alaska.[1]

A few imperfect ammonites have also been found in the exposures bordering Cold Bay from beds overlying the *Pseudomonotis* layer. These ammonites, when generically determined, may possibly indicate a still higher horizon of Triassic.

JURASSIC SYSTEM.

LOWER JURASSIC ROCKS.

No rocks in the Alaska Peninsula have yielded Lower Jurassic fossils, but at Cold Bay there are nearly 4,000 feet of shales and sandstones, as reported by Stanton and Martin,[2] between the known Triassic horizon and the Middle Jurassic. The exact position of these rocks has not been determined by paleontologic evidence. In the vicinity of Cold Bay the unconformity between the Triassic and Jurassic, known to exist farther north on the shores of Cook Inlet, is not obvious, and the boundary between the two systems has not yet been definitely fixed. The structural relations are obscured at several points by faults.

GRANITES AND SYENITES, PROBABLY OF LOWER OR MIDDLE JURASSIC AGE.

One area in the northwestern portion of the peninsula (Pl. VI, in pocket), at the west end of Becharof and Naknek Lakes, is composed of igneous rocks, which are of pre-Upper Jurassic age or older. This belt was crossed by Spurr in 1898, and reported [3] by him to be composed of coarse-grained granitic rocks, and to occupy a considerable area on the northwest side and parallel with the main trend of the peninsula. Some syenite and an extensive outcrop of hornblende granite-aplite were also found by Spurr in the area bordering the lower end of Naknek Lake.

The sedimentary rocks adjoining this area and extending southeastward are of late Jurassic age, and contain an abundance of arkose and some conglomerates. The resemblance of the granite pebbles in the conglomerates and of the granitic material in the arkoses suggest that the material for these sedimentary formations may have been derived from the neighboring crystalline rocks, and that the latter

[1] Stanton, T. W., and Martin, G. C., op. cit., p. 396.
[2] Idem, p. 397.
[3] Spurr, J. E., A reconnaissance in southwestern Alaska: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1898, p. 232.

are, therefore, at least of pre-Upper Jurassic age. Mount Douglas and the neighboring peaks have been reported by R. W. Stone to be composed of coarsely crystalline rocks.

No other igneous rocks on the peninsula have been found in such relations as to suggest for them an age preceding that of the Upper Jurassic rocks. In the Herendeen Bay district the Upper Jurassic sediments are composed of conglomerates and arkoses, which suggest the proximity of an exposure of granitic rocks to that region during late Jurassic time.

The age of these rocks has therefore not been definitely determined, but G. C. Martin has informed the writer that similar large areas of granitic rocks of early Jurassic or mid-Jurassic age exist a little farther north and are probably the continuation of the area reported by Spurr in 1898.

MIDDLE JURASSIC ROCKS ("ENOCHKIN FORMATION").

Character and distribution.—The Middle Jurassic is well exposed on the east shore of Enochkin Bay, a small reentrant on the west side of Cook Inlet about 40 miles north of the northeast terminus of the Alaska Peninsula as herein defined. These rocks cover a large area in the vicinity of Cold Bay (Pl. VI, in pocket), and the occurrence of *Cadoceras wossenessenskii*, near Katmai, reported by Grewingk, indicates another possible locality for their occurrence on the peninsula. Stanton and Martin [1] measured 1,650 feet of Middle Jurassic sandstones, shales, and conglomerates on the shores of Enochkin Bay, and these observers estimated that at least half the total thickness was concealed.

Because of the development of the Middle Jurassic rocks in the Enochkin Bay region the name "Enochkin formation" was applied to the beds. Of the exposures of these rocks in the Cold Bay region Martin [2] has said:

> The Enochkin formation occupies both shores of Cold Bay except at the northeastern promontory (Cape Kekurnoi) and at the head of the bay. It also extends in a belt along the shore of Shelikof Strait from Cold Bay to Dry Bay and probably as far beyond as Portage Bay.

On the same page he gives the following measured section, which is exposed on the east side of Rex Creek, about 1 mile above the head of Dry Bay:

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[1] Stanton, T. W., and Martin, G. C., op. cit., p. 398.

[2] Martin, G. C., Petroleum fields of the Pacific coast of Alaska: Bull. U. S. Geol. Survey, No. 250, 1905, p. 53.

Mesozoic section on Rex Creek, Cold Bay region.

	Feet.
Naknek formation;	
Arkose, sandstone, and shale	600+
Enochkin formation;	
Shale and sandstone	500
Sandstone	90
Argillaceous shale	400
Sandstone, shale, and conglomerate	300

Fauna and flora.—The paleontologic evidence from the Cold Bay exposures of the "Enochkin formation" has been presented as follows:[1]

This portion, which we have mentioned as "zone D," or the "*Cadoceras* zone," has been recognized by its fossils from Snug Harbor to Cold Bay. Its characteristic ammonites have been assigned to the Callovian by Neumyr, Hyatt, and Pompeckj, all of whom recognized the character of the fauna, which is represented by closely similar forms in Russia, Franz Josef Land, and elsewhere in northern regions, as well as in other parts of Europe. This Callovian fauna is placed by many geologists in the lower part of the Upper Jurassic, but it seems to accord better with the local development in Alaska to follow the custom of some German geologists and assign it to the top of the Middle Jurassic. Seven species of *Cadoceras* have been named from Alaska, some of which will evidently become synonyms when the large collections now on hand are fully studied, and possibly one or two additional names will be necessary. With these are associated *Spæroceras*, *Phylloceras*, and one or two other genera of ammonites, belemnites, and a very few pelecypods and gastropods.

A few plants, referred by Dr. F. H. Knowlton[2] to *Cladophlebis denticulata*, *Ctenis grandifolia*, *Hausmannia* sp., and *Dictyophyllum* cf. *D. obtusilobum*, have been found with the marine invertebrates.

UPPER JURASSIC ROCKS.

NAKNEK FORMATION.

Name and original description.—The Naknek formation was first described by Spurr[3] from the vicinity of Naknek Lake and Katmai. He says of it:

The Naknek series consists of a great thickness of granitic arkose and of conglomerate which generally contain pebbles of granite. All of these sedimentary rocks are evidently derived from the destruction of a land mass which consisted largely of hornblende-biotite granite. There are probably some volcanic flows interstratified with the arkose and conglomerates, although it is not absolutely proved that those examined may not be intrusive. The series is cut by andesite-basaltic (aleutitic) lava of later age, especially along the axis of the range, where the amount of volcanic rock is very great.

Throughout the whole series the arkoses carry abundant fossil remains, both of plants and of marine organisms.

[1] Stanton, T. W., and Martin, G. C., The Mesozoic section on Cook Inlet and Alaska Peninsula: Bull. Geol. Soc. America, vol. 16, 1905, p. 401.

[2] Op. cit.

[3] Spurr, J. E., A reconnaissance in southwestern Alaska: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1898, pp. 169-171.

Elsewhere Spurr alludes to the presence of beds of gray compact limestone in the formation, and on page 180 he adds:

> Throughout the whole series are abundant plant remains, which, so far as examined, were not determinate, and marine faunal remains that indicate a probable Upper Jurassic age.

He estimated the thickness exposed in the mountains near Katmai as at least 1,500 feet. The section exposed on the cliffs on the east side of Katmai Bay was described as consisting of hard and massive dark-gray arkose at the bottom, overlain by a probable flow of massive andesite, above which are other beds of arkose and conglomerate. The gray compact limestone with Jurassic fossils is found at various points in the rocks.

Character and distribution.—At the extreme northeastern margin of the peninsula, on the shores of Kamishak Bay, the Naknek formation is well exposed. Here the formation consists largely of sandstones which are very fossiliferous.

The Naknek formation probably occupies a large portion of the peninsula in the vicinity of Katmai and Naknek Lake (Pl. VI) and extends southward beyond Cold Bay and Becharof Lake. Martin has made the following report regarding it:[1]

> The Naknek formation forms the shore of the head of Cold Bay and occupies the entire interior region as far west as Becharof Lake and as far north as Katmai.

On the same page he states that a section in the Naknek formation exposed in Rex Creek about 1 mile above the head of Dry Bay, the first bay south of Cold Bay, includes somewhat more than 600 feet of arkose, sandstone, and shale.

The distribution of this formation in the Chignik Bay and Herendeen Bay districts is indicated on Plates VII and VIII. The Naknek formation is exposed in the axis of the Aleutian Range in the Chignik Bay region. The detailed mapping was not completed in this region, but the formation probably occupies a considerable belt through the central portion of the peninsula. It consists here of a series of sandstones, shales, and conglomerates. The sandstones of the Naknek formation exposed on the shores of Chignik Lagoon and on the shores of Chignik Lake are fine-grained and firmly cemented rocks of dark-gray colors. These exposures yielded collections of fossil invertebrates, which will be referred to later as collections No. 58a and No. 56, respectively. Northwest from the head of Hook Bay the Upper Jurassic is represented by thin-bedded sandstones, which yielded fossil collection No. 50, and by some grits, conglomerates, and shales.

In the Herendeen Bay region the Upper Jurassic outcrops are limited to a few projecting points near the head of the bay, and to

[1] Martin, G. C., Petroleum fields of the Pacific coast of Alaska: Bull. U. S. Geol. Survey No. 250, 1905, p. 53.

one locality in the small peninsula between Herendeen Bay and Port Moller. In this region the formation is north of the main anticlinal axis of the Aleutian Range and in the central portions of minor double-plunging anticlines that have been deeply dissected, first by running water and later by ice erosion. In this region the Naknek formation is limited to areas lying within 1,000 feet of sea level and is composed of sandstones, shales, conglomerates, grits, and arkose. The sandstones and arkoses appear to have come from rocks of a granitic nature, and the conglomerates contain an abundance of quartz pebbles that may have come from granitic rocks.

The sections measured near the base and on the east side of Pinnacle Mountain, near the head of Herendeen Bay, is given below:

Section of Naknek formation.

	Feet.
Sandstone, coarse grained and fossiliferous (yielded collection No. 22)	600
Sandstone, medium grained (with a few fossils)	100
Sandstone, fine grained and fossiliferous (yielded collection No. 21)	50
Grit or coarse gritty sandstone	30
Sandstone, dark colored and very fine grained (yielded collection No. 14)	300

Fauna.—Stanton has made the following report on the paleontologic material referred to above and on other collections obtained from the Naknek formation in the Herendeen Bay and Chignik Bay regions during the season of 1908:

Collections of fauna of the Naknek formation.

No. 14. East base of Pinnacle Mountain, Herendeen Bay:
- Pecten sp. a.
- Pecten sp. b.
- Pecten? sp. c.
- Aucella sp. related to *A. bronni* Rouillier.
- Arca sp.

No. 15. Bold Bluff Point, Herendeen Bay:
- Aucella sp. related to *A. bronni* Rouillier.

No. 21. Canyon on east face of Pinnacle Mountain, Herendeen Bay:
- Aucella sp. related to *A. bronni* Rouillier.

No. 22. Canyon on east face of Pinnacle Mountain, above horizon that yielded collection No. 21:
- Terebratula sp.
- Pecten sp. Large, smooth form.
- Avicula sp.
- Aucella sp. related to *A. pallasi* Keyserling.
- Cyprina sp.
- Pleuromya sp.

No. 24. Crow Point, Herendeen Bay:
- Eumicrotis sp.
- Aucella sp. related to *A. pallasi* Keyserling.

No. 24. Crow point, Herendeen Bay—Continued.
Cyprina sp.
Pleuromya sp.
Belemnites sp.
No. 25. Crow Point, Herendeen Bay:
Aucella sp. related to *A. pallasi* Keyserling.
No. 26. Crow Point, Herendeen Bay:
Pecten sp. Large, smooth form.
Eumicrotis sp.
Aucella sp. related to *A. pallasi* Keyserling.
Cyprina sp.
Pleuromya sp.
No. 27. Crow Point, Herendeen Bay:
Same species as in 26 with Tancredia and Belemnites additional.
No. 50. North side of Chignik Bay, on mountain top north of Bear Creek.
Lima sp. related to *A. bronni* Rouillier.
Turbo sp.
Belemnites sp.
Horizon, Upper Jurassic.
No. 56. Chignik Lake, in fine-grained dark-colored sandstone exposed along the shore in the southwest arm of the lake:
Aucella sp. related to *A. bronni* Rouillier.
Horizon, Upper Jurassic.
No. 58a. Chignik Lagoon, about opposite Alaska Packers' Association's cannery:
Lima sp.
Aucella sp. related to *A. bronni* Rouillier.
Phylloceras? sp. Fragmentary imprint.
Horizon, Upper Jurassic.
No. 59. Hook Bay Creek, near coal mine:
Aucella sp. related to *A. pallasi* Keyserling.
Horizon, Upper Jurassic.

Stanton has discussed the faunal relations of the Naknek formation as follows:[1]

The fauna of the Naknek formation is especially characterized by the presence of *Aucella* belonging to species very closely related if not identical with *A. pallasi* and *A. bronni* of the Russian Volga beds. These fossils are at some localities very abundant, completely filling thick beds. At other places they are so rare that they may be easily overlooked, but a careful search will find them in almost every section. Associated with the *Aucella* there are usually two or three species of *Belemnites*, frequently a large *Lytoceras* and a *Phylloceras*, and occasionally a few gastropods, *Trigonia*, and other pelecygods. It is clear that the Naknek formation is of about the same age as the Mariposa beds of California with *Aucella erringtoni* and *Cardioceras* cf. *alternans*,[2] and it also includes the horizon of the marine Jurassic with *Cardioceras cordiforme* in the Black Hills, where, however, the *Aucella* element is lacking from the fauna, and probably only the horizon of the basal portion of the Naknek is represented. A similar fauna occurs in Russia in the Volgian beds, and it is widespread in the boreal region, occurring on Spitzbergen, Nova Zembla, and elsewhere.

Structure and stratigraphic relations.—At the northeastern extremity of the peninsula, and a little west of Cape Douglas, the Naknek sedi-

[1] Stanton, T. W., and Martin, G. C., The Mesozoic section of Cook Inlet and Alaska Peninsula: Bull. Geol. Soc. America, vol. 16, 1905, p. 407.

[2] Two names, *C. whitneyi* Smith and *C. dubium* Hyatt, have been proposed for probably the same species in this formation.

ments rest in a nearly horizontal position, but their relations to other formations in that part are not as yet known. In the central portion of the peninsula, between Katmai and Naknek Lake, the Naknek strata are gently folded. They are reported by Spurr to be upturned on either side of the belt of volcanic rocks which occupy the axis of the Aleutian Range in this portion of the peninsula.

A little farther south in the Cold Bay-Becharof Lake region there is a series of anticlines and synclines with nearly parallel axes trending in a general northeast-southwest direction.

The section there exposed is given in the following table:

General section in the Cold Bay-Becharof Lake region.[a]

Formation.	Age.	Lithologic character.	Thickness.
			Feet.
	Post-Jurassic.	Volcanic rock, probably andesite or basalt.	
Naknek formation.	Late Jurassic.	Arkose, conglomerate, sandstone, and shale.	3,000-5,000
"Enochkin" formation.	Mid-Jurassic.	Shale, sandstone, and a little limestone.	2,000
	Triassic.	Shale, limestone, and chert.	
	Pre-Jurassic.	Granite, syenite, etc.	

[a] Martin, G. C., Petroleum fields of the Pacific coast of Alaska: Bull. U. S. Geol. Survey No. 250, 1905, p. 52.

The main anticlinal axis in this region extends from Kanata, at the head of Portage Bay northeastward between Becharof Lake and Cold Bay (Pl. VI, in pocket). There is a syncline parallel to this main fold extending from the region about the mouth of Oil Creek northeastward nearly to the shores of Cold Bay, where it is cut off by a fault. The exposure of Triassic rocks and the northwestward dip of the strata farther northeast on the north side of Cold Bay seem to indicate another anticlinal axis which may pass through the headlands along the coast.

A synclinal trough passes northwest of the main anticlinal fold in a northeast-southwest direction through Becharof Lake, and still farther west at the lower end of the lake is another upturning of the sedimentary formations and an exposure of coarsely crystalline rocks. The dips are low over wide areas and the zones of steep dip are narrow and infrequent. Observed dips near Cold Bay vary, none exceeding 16°.

In the Chignik Bay region (Pl. VII) the base of the Naknek formation was not seen, but an erosion plane separates this formation from the overlying Upper Cretaceous sediments. This unconformity is perhaps best shown on the northwest coast of Chignik Bay near the entrance to Chignik Lagoon and on the northwest shore of that lagoon. At these localities the structural break is distinct and fossil material is available from both horizons. In the exposure west of Hook Bay the Naknek strata stand at angles as high as 50°, and

when the structural relations in this portion of the field are worked out in detail they will probably demonstrate a great structural break between the Upper Jurassic and the Upper Cretaceous. In the exposures about the shores of Chignik Lake the Naknek beds appear in broad open folds, the departure from horizontality usually being less than 10°.

The main anticlinal axis in this region has a northeast-southwest direction passing through Chignik Lake (Pl. VII) and following the crest line of the Aleutian Range in either direction (fig. 1, p. 28). The axis is about 8 miles west from the head of Hook Bay and apparently continues northeast in the direction of Portage Bay, where it may become continuous with the axis extending northward from the head of that bay and between Becharof Lake and Cold Bay. The northwest side of this fold was not seen to advantage in the Chignik Bay region, but on the southeast there are a number of gentle folds shown in the bold headlands on the south side of the bay from Chignik Lagoon to Castle Cape (Pl. V, *A*, p. 38) at the southern entrance to Chignik Bay.

In the Herendeen Bay region (Pl. VIII) the Naknek formation is exposed in the central portions of dissected anticlines, and the beds rest at angles not exceeding 20°. In this region, especially in the Crow Point exposures, the formation is much faulted, and the base is not exposed. One of the contacts with the Lower Cretaceous is by faulting; the other is obscured by talus accumulations and vegetation. The stratigraphic relations between the Upper Jurassic and Lower Cretaceous in this region are therefore not yet known. The general structural conditions in this portion of the peninsula are given in figure 2 (p. 28). More detailed sections are given in figures 5 (p. 59) and 13 (p. 97).

CRETACEOUS SYSTEM.

LOWER CRETACEOUS ROCKS.

Two distinct Lower Cretaceous formations are exposed in the Herendeen Bay reigon, but have not yet been recognized elsewhere in the peninsula. They outcrop on the east shore of Herendeen Bay and extend northeastward through the coal field to the vicinity of Hot Springs on the shores of Port Moller. (See Pl. VIII.)

STANIUKOVICH SHALE.

A series of shales that constitute a large part of Staniukovich Mountain, a peak 2,400 feet high, overlooking the entrance to Port Moller, has been called the Staniukovich shale. The mountain was named for Capt. Mikhail Nikolaievich Staniukovich, who was in

A. TULIUMIT POINT, LOCALLY KNOWN AS CASTLE CAPE, AT SOUTH ENTRANCE TO CHIGNIK BAY.

See pages 38, 92.

B. EAST COAST OF UNGA ISLAND NORTH OF UNGA HARBOR.

The composition and structural relations of this cliff are shown diagrammatically in figure 10. See page 70.

command of the sloop *Moller* on a surveying expedition to this part of Alaska in the year 1828.

The Staniukovich shale, which makes up the lower portion of the Lower Cretaceous of this region, includes at least 1,000 feet of shales with thin beds of sandstone. This formation underlies conformably the Herendeen limestone and is lithologically very different from the sediments composing the Naknek formation, of late Jurassic age. The Staniukovich shale is well exposed in Staniukovich Mountain and in the north wall of Lawrence Valley. The shales are thin bedded, and talus material forms upon them so rapidly that they weather down to softened slopes of dull reddish colors without striking physical characters.

HERENDEEN LIMESTONE.

The upper portion of the Lower Cretaceous of this region is an arenaceous limestone of light-gray color, locally cross-bedded and fossiliferous. The formation is 800 feet thick, and owing to its superior resistance to the agents of weathering it has come to form conspicuous ridges in the coal field.

The Herendeen rock is a yellowish, sand-colored fine-grained limestone, with numerous minute plates of black mica on the sedimentation planes. Locally it contains abundant fragments of shells and, at places where the shell forms are lost the comminuted shell material may be recognized. The shells that have yielded most of such material were pectens. A microscopic examination[1] of this rock shows that it is "mainly composed of dirty carbonate occurring in small short rectangular forms, but longer pieces are found, and these show curvature indicating a detrital organic origin. Throughout the section are scattered subangular fragments of quartz and plagioclase and sporadic flakes of biotite; as accessories there occur fragments of pyroxene, of rounded microlitic andesite, and grains of magnetite."

The Herendeen limestone, though folded and somewhat faulted, may be traced east from Coal Harbor for several miles, thence northwest until it outcrops on the shore of Herendeen Bay a little north of Coal Harbor. These outcrops are on the sides of a plunging syncline. Farther north the same arenaceous limestone outcrops again on the flanks of a neighboring anticline and extends east below recent volcanic tuffs and flows until it outcrops on the west shore of Port Moller.

FAUNA.

Several collections of invertebrate forms have been secured from these Lower Cretaceous formations, and from an examination of this material Dr. Stanton has recognized two horizons. The higher

[1] The description of the microscopic characters of the rocks given in this report is by Adolph Knopf.

horizon contains forms related to *Aucella crassicollis* and the lower forms related to *Aucella piochii*. The localities at which these collections were made are given below in Dr. Stanton's report:

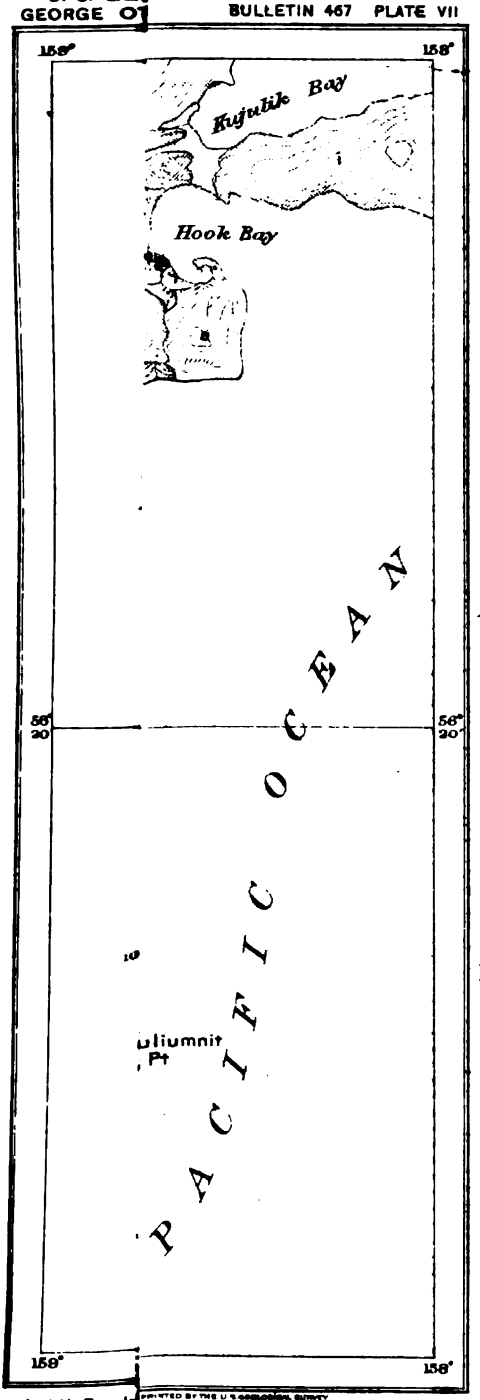
Collection of Lower Cretaceous fauna.

No. 13. West side of the basin of Coal Valley and about 500 feet above sea level.
Aucella sp. related to A. piochii Gabb.
Aucella sp. related to A. crassicollis Keyserling.
No. 16. Just south of Shingle Point east side of Herendeen Bay.
Aucella sp. related to A. crassicollis Keyserling.
No. 17. Between Shingle Point and Marble Point, east side of Herendeen Bay.
Aucella sp. related to A. piochii Gabb.
No. 28. From high ridge south of Johnson tunnel in Mine Creek.
Aucella sp. related to A. crassicollis Keyserling.
No. 29. From 1,100 foothills about 3 miles northeast of Mine Harbor.
Same Aucella as in 28.
No. 33. Sandstone near Hot Springs, Port Moller.
Aucella sp. related to A. crassicollis Keyserling.
Pecten sp., large, smooth form.
No. 34. From shales exposed one-half mile north of Hot Springs, Port Moller.
Inoceramus sp.
Pleuromya sp.
Belemnites sp.
Desmoceras? sp.

All of the collections that contain forms related to *Aucella crassicollis* Keyserling, except collection No. 13, are known to have come from the Herendeen limestone. Collection No. 17, with forms related to *Aucella piochii*, came from the Staniukovich shale. Collection No. 13, which contains both the above types, was secured from what was believed to be the Herendeen limestone, but the formation could not be absolutely identified because much of the region was covered by a heavy mantle of snow.

STRATIGRAPHIC RELATIONS.

As has already been stated, the Herendeen limestone and Staniukovich shale are sections of a conformable series. The base of the Staniukovich has not as yet been seen in contact with any other formation, so the structural relations at that horizon are not known. In Crow Point near the mouth of Lawrence Valley there are good exposures of Upper Jurassic rocks, but this area is structurally separated from the north wall of Lawrence Valley, where the Lower Cretaceous formations outcrop, by a fault. In Coal Valley the base of the Lower Cretaceous is obscured by loose material and vegetation. The paleontologic material collected from the section exposed on the east side of Pinnacle Mountain includes an abundance of Upper Jurassic forms from the lower 400 feet and some Upper Cretaceous material at 900 feet above the sea. The intervening strata from 400 to 900 feet have been mapped as Upper Cretaceous, but the possi-



Alfred H. Brook
Topography by
Surveyed in
Geodetic positi
PRINTED BY THE U. S. GEOLOGICAL SURVEY
y Wallace W. Atwood
n 1908 under the direction of Alfred H. Brooks

LEGEND

QUATERNARY

Qal — Alluvium

Pumice

Qgd — Glacial drift

TERTIARY

i — Recent volcanics
Chiefly agglomerate, with associated basaltic dikes and flows

a? — Probable extension of andesites and dacites

a — Andesites and dacites, with some volcanic tuffs and breccias

Tk? — Probable extension of the Kenai formation

Kenai formation
Sandstones, shales, and conglomerates, with some lignite

CRETACEOUS

Kc? — Probable extension of the Upper Cretaceous coal-bearing series

Chignik formation
Sandstones, shales, and conglomerates, with some valuable coal seams

UPPER JURASSIC

J? — Probable extension of Naknek formation

Naknek formation
Sandstone, shales, and conglomerates; marine

Fault

Strike and dip
Coal mine
Coal prospect
Copper prospect
Gold prospect

bility remains that Lower Cretaceous formations are in part represented in this section.

In the coal field east of Herendeen Bay the relation of the Lower Cretaceous formations to the coal measures, which have been judged to be of late Cretaceous age, appears to be that of conformity. The age of the coal measures will be considered later.

UPPER CRETACEOUS ROCKS.

CHIGNIK FORMATION.

Character and distribution.—The name Chignik formation is here used for the first time. The formation is well exposed at several places along the shores and at points near to Chignik Bay and Chignik Lagoon. The type section is exposed in Whalers Creek, one-half mile from the shore of Chignik Lagoon.

Upper Cretaceous rocks have been definitely recognized in the Herendeen Bay and Chignik Bay regions and in a small area a short distance north of Douglas village, near the northeastern end of the peninsula (Pl. VII, p. 40).

The exposures north of Douglas village consist of a series of shales and sandstones whose thickness is estimated at 2,000 feet. In the Chignik Bay region the Chignik formation consists of a series of sandstones, shales, conglomerates, and some valuable coal seams. The sandstones range from fine, even-grained sediments to grits. Many of the sandstones in this formation, as exposed in Nigger and Chignik Heads, have a light green color when fresh, but weather to black or to shades of brown in the cliffs. Ripple marks are not uncommon on the bedding planes, and in some of the strata there are large concretions. The conglomerates are conspicuous members in the series, for they are firmly cemented and form cliffs or even, in some places, overhanging ledges. These conglomerates in Chignik Head contain pebbles of granite, quartz, greenstones, and flint as large as 2 inches in diameter. Near the entrance to Chignik Lagoon there is a coarse conglomerate that for convenience in the field was spoken of as the cobble conglomerate. The stones in this conglomerate are commonly 3 or 4 inches in diameter, but some of the bowlders found in it were 2 feet in diameter. This conglomerate is poorly bedded and in some places has a volcanic matrix. The stones include granites, basalts, quartz, and shale. There are lenses of sandstone and shale in the midst of the conglomeratic layer.

The section as exposed along the shore of Chignik Lagoon and out to Nigger Head is given below.

Section of Chignik formation near Nigger Head, Chignik Bay.

	Feet.
Conglomerate	100
Black shales	90
Conglomerate	80
Black shale (yielded collection No. 53, invertebrates)	100
Cobble conglomerate	150
Shales with interbedded conglomerate	60
Sandstones and shales at Nigger Head (the shales yielded collection No. 49, plants)	200
	780

Many other good exposures of the Upper Cretaceous rocks occur along the northwest shores of Chignik Bay and Chignik Lagoon, and in the mountain valleys to the northwest. In Thompson Valley, along Whalers Creek, and along the banks of Chignik River near the coal mine the formation is equally well shown. In the exposures northwest of Chignik Bay and Chignik Lagoon the series is coal bearing, and the exposures in this portion of the field will therefore receive special attention later in the report. The distribution and probable extension of the Chignik formation in this region are shown on Plate VII (p. 40).

The Upper Cretaceous rocks are exposed at several places in the Herendeen Bay district. (See Pl. VIII, p. 42.) There is one small area in the central part of the peninsula, midway between Balboa and Herendeen Bays and on the north side of a large laccolithic intrusion. The larger exposures are in the vicinity of Herendeen Bay, where the upturned Chignik strata appear on the flanks of anticlinal and synclinal folds. West of the west arm of Herendeen Bay the Upper Cretaceous sediments are near the base of the mountains. The basal portion of Pinnacle Mountain is composed in part of the Chignik formation, as is also a portion of the south wall of Lawrence Valley. Coal has been reported along the tributaries of Lawrence Valley from the south, and it is quite possible that productive seams may be located there. In the coal field as now defined the Chignik formation outcrops in a westward plunging syncline east of coal Harbor, at Coal Bluff on the east shore of Herendeen Bay, and over a large area east of the head of Coal Valley. The formation consists of a series of sandstones, shales, conglomerates, and coal. The section exposed in Mine Creek and about 1½ miles east of Coal Harbor includes:

Section of Chignik formation in Mine Creek.

	Feet.
Conglomerate	300+
Coal measures	300+
Shales	200±

Detailed measurements of the coal measures are given on page 98. The conglomerate overlying the coal measures, which has a thickness of about 300 feet, is well exposed in the cliff north of Coal Bluff, on the east shore of Herendeen Bay, and in the canyon portion of the valley of Mine Creek. This conglomerate contains pebbles of quartz, chert, greenstone, and sandstone, generally between 1 and 2 inches in diameter, but not uncommonly grading up to 4 inches in diameter.

Fauna and flora.—Upper Cretaceous fossil material has been secured from several localities in the Chignik Bay region. Shells have been obtained from Chignik Head just east of Anchorage Bay (collection No. 45), from points along the north shore of Chignik Bay northeast of the entrance to Chignik Lagoon (collection No. 52), from exposures on the northwest shore of Chignik Lagoon (collection No. 58), and from the southeast shore near the entrance of the lagoon (collection No. 53). Similar invertebrate collections have been secured from the coal measures exposed in Whalers Creek, northwest from the upper end of Chignik Lagoon (collection No. 51). Stanton's report on these collections is as follows:

Collections of fauna of the Chignik formation in the Chignik Bay region.

No. 45. Chignik Head, east of entrance into Anchorage Bay:
Inoceramus sp. related to I. vancouverensis Shumard.
Horizon, Upper Cretaceous or older. Similar forms of Inoceramus range down to the Jurassic.

No. 51. Whalers Creek, 2 miles above mouth of stream, Chignik Lagoon:
Anomia sp.
Inoceramus digitatus Sowerby.
Axinæa veatchi Gabb.
Meretrix nitida Gabb.
Meretrix sp.
Tellina nanaimoensis Whiteaves.
Tellina sp.
Perissolax brevirostris Gabb?
Horizon, Upper Cretaceous. The fauna is the Chico fauna of the Pacific coast especially as developed in the Nanaimo formation of Vancouver Island.

No. 52. North side of Chignik Bay, 1 mile north by east from head of sand spit:
Anomia sp.
Inoceramus digitatus Sowerby.
Axinæa veatchi Gabb.
Clisocolus sp.
Meretrix nitida Gabb.
Tellina nanaimoensis Whiteaves.
Mactra sp.
Solarium sp.
Perissolax brevirostris Gabb.
Fusus? sp.
Volutoderma sp.
Pachydiscus? sp. represented by a single immature ammonite.
Horizon, Upper Cretaceous, same horizon as on Whalers Creek.

No. 53. Northeast of Alaska Packers' Association cannery and 200 yards southwest of native village:

Rhynchonella sp.
Inoceramus sp. Fragments.
Nucula sp.
Leda sp.
Trigonia sp.
Hamites? sp. Fragments.

Horizon, certainly Mesozoic and presumably Upper Cretaceous. The fossils indicate a different horizon, or at least a different facies, from the one represented at neighboring localities from which Cretaceous collections were obtained.

No. 58. Chignik Lagoon, about opposite Alaska Packers' Association cannery:

Anomia sp.
Inoceramus digitatus Sowerby.
Axinæa veatchi Gabb.
Meretrix nitida Gabb.
Pachydiscus? n. sp.

Horizon, Upper Cretaceous, same horizon as on Whalers Creek.

From the same series of beds which yielded the Upper Cretaceous invertebrates three collections of plant forms were procured. Knowlton's report on these collections is as follows:

Collections of plant forms of the Chignik formation in the Chignik Bay region.

No. 49. South side of Chignik Lagoon, near entrance:

Taxodium? sp.
Sequoia rigida Heer?
Pterophyllum lepidum? Heer.
Adiantum formosum Heer.
Ferns, two species.
Dicotyledons.

This I presume to be Upper Cretaceous.

No. 54. Chignik River just below Long Bay:

Trapa? microphylla Lesq.

This collection contains a large number of specimens of this species. This is very interesting, and so far as I now recall is the first time it has been found beyond the central Canadian provinces. This form of Trapa was at first supposed to be characteristic of the Montana (Upper Cretaceous), but it has now been found to have so wide a vertical range that it can not be employed in close fixation of age, though I should incline to think it probably Cretaceous.

No. 55. Chignik River just below Long Bay, 30 feet above collection No. 54.

Pterophyllum lepidium? Heer.
Conifers, ferns, and dicotyledons.

Apparently same age as collection No. 54.

Hollick determined collections 49 and 55 as Upper Cretaceous or lower Tertiary, but did not reach a conclusion regarding the age of collection 54.

During the year 1904 Stanton collected some fossil material along the border of Chignik Lagoon, from about the same locality where collection No. 49 was made. These plants were identified by Knowlton and include the following Upper Cretaceous species:

Osmunda arctica.
Sequoia reichenbachi.
Sequoia rigida.
Taxodium sp.
Torreya brevifolia.
Anomozamites schmidti.
Zamites sp.
Myrica sp.
Quercus johnstrupi.
Quercus n. sp.
Ziziphus sp.

Regarding the other material procured in this vicinity Stanton writes as follows:[1]

The shales above the conglomerates yielded *Inoceramus* fragments, *Pecten*, *Nucula* (*Scila*) cf. *truncata*, *Corbula*, *Thracia*, *Dentalium*, *Cinulia*, and some undetermined ammonoid fragments.

At the locality on Whalers Creek Mr. R. W. Stone obtained an *Inoceramus*, related to *I. digitatus*, a *Trigonia* of the type of *T. leana*, and *Anomia*.

These fossils indicate correlation with a horizon in the Chico as developed in California and in the Nanaimo of Vancouver Island, which include practically all of the Upper Cretaceous, but the beds at Chignik are probably not older than basal Senonian.

The identification of the Upper Cretaceous in the Herendeen Bay region rests in part upon invertebrate forms and in part upon plant remains. Invertebrate forms have been secured from the small area north of the laccolithic mountain midway between Balboa and Herendeen bays, from the south side of Pinnacle Mountain 900 feet above tide, from the base of the mountains west of the west arm of Herendeen Bay, and from the coal measures in the valley east of Coal Harbor. In these collections Stanton has recognized the following forms:

Pachydiscus multisulcatus Whiteaves.
Inoceramus sp. of type of I. cripsi Mantell.
Inoceramus digitatus Sowerby.

Paige spent a few days in the Herendeen Bay coal field in 1905[2] and collected invertebrate material from the coal measures, on which Dr. Stanton made the following report:[3]

The lots that are the most interesting, because they are entirely new to the region, are those from the Upper Cretaceous. These are from the following localities: (1) Big exposure on left fork of Coal Creek, just above coal; (2) 200 yards above left fork of Coal Creek; (3) just above Johnson tunnel.

The last-mentioned lot contains only fragments of *Inoceramus* and the age is somewhat questionable, but the other two lots contain abundant and well-preserved examples of *Inoceramus digitatus* Sowerby, which is a peculiar type known only from the Upper Cretaceous. The same species has been found associated with coal at Chignik, and it also occurs in the coal-bearing Cretaceous rocks of Vancouver Island.

Pompeckj, who restudied the old collection of Wossnessenski from near Katmai, reports a specimen of *Belemnitella* labeled as coming from that place, and on that account infers the presence of Upper Cretaceous there, but this lacks confirmation. The exposures north of Douglas Village have yielded a few fragmentary specimens of a large *Inoceramus* and a *Desmoceras* (?).[4]

[1] Stanton, T. W., and Martin, G. C., the Mesozoic section on Cook Inlet and Alaska Peninsula: Bull. Geol. Soc. America, vol. 16, 1905, p. 408.
[2] Paige, Sidney, The Herendeen Bay coal field: Bull. U. S. Geol. Survey No. 284, 1906, p. 301.
[3] In this report the name "Coal Creek" was used instead of Mine Creek, as given on the maps accompanying this report.
[4] Stanton, T. W., and Martin, G. C., The Mesozoic section on Cook Inlet and Alaska Peninsula: Bull. Geol. Soc. America, vol. 16, 1905, p. 409.

These specimens probably indicate the presence of Upper Cretaceous beds.

The plant collections from the coal measures near Herendeen Bay have not been entirely satisfactory, for it has not been possible, from the material secured, to determine many of the species. The marked presence of certain types of cycads indicates a Cretaceous age for the coal measures, but does not fix satisfactorily their place in the Cretaceous. From a study of the plant collections Dr. Knowlton has made the following report:

Collections of plant forms from Chignik formation of the Herendeen Bay coal measures.

No. 30. Coal series, Mine Creek, Herendeen Bay:

Sequoia langsdorfii? (Brongn.) Heer. cf. Phaseolites formus Lesquereux.
Fragments of dicotyledons.

Age uncertain, as indicated by the plants.

No. 35. Two miles up canyon west from the head of Mud Bay, an arm of Port Moller:

Anomozamites sp.
Pterophyllum sp.
Nilsonia sp.
Hausmannia sp.
Ginkgo sp.
Quercus? sp.
Betula? sp.
Taxodium or Sequoia sp.

I do not know exactly where to place this lot, as I have not been able to positively determine any species, but from the marked presence of cycads of these types I regard it tentatively as Cretaceous.

Paige [1] procured an abundance of plant fossils from the coal measures exposed in the valley east of Coal Harbor, and an extract of Knowlton's report on this material is given below:

Coal Creek,[2] right branch below first side stream:

Anomozamites cf. A. schmidtii Heer.
Cone, probably of Sequoia.
Fragments of dicotyledons.

Right bank of Coal Creek, first tunnel:

Sequoia sp.?
Pterophyllum cf. P. concinnum Heer?

The age of these beds as indicated by the meager plant remains is Cretaceous, and probably similar to the beds on Chignik Bay, from which Dr. Stanton obtained a Cretaceous flora.

One-half mile above left branch of Coal Creek, 200 feet above fork right branch Coal Creek, big exposure left fork Coal Creek, the plant remains, aside from a fragment of a dicotyledon, consist entirely of delicate coniferous branchlets. This species was at first supposed to be *Taxodium distichum miocenum*, but more careful study appears to indicate that it is an undescribed species of *Sequoia*. The age of these beds in uncertain, but is probably similar to that of the other lots. None of the present lots contain any of the species found in the material collected at Herendeen Bay by Townsend.

After examining the floral material collected in the Herendeen Bay region by Paige in 1905 and by the writer in 1908, Hollick con-

[1] Paige, Sidney, The Herendeen Bay coal field: Bull. U. S. Geol. Survey No. 284, 1906, p. 103.
[2] "Coal Creek" refers to Mine Creek (see Pl. II).

cludes that there is in this region a floral horizon which is either Eocene or Upper Cretaceous and which "may be correlated with floral complex of the lower Yukon Valley."

Stratigraphic relations.—Nothing is known of the relations of these sediments to other rocks in the northeastern part of the peninsula, but some data from the Chignik and Harendeen Bay regions is now available. In the Chignik Bay region the Upper Cretaceous rocks (Chignik formation) rest unconformably upon the Upper Jurassic (Naknek formation). The unconformity is well shown on the northwest side of Chignik Bay, a short distance east of the sand spit at the entrance to Chignik Lagoon, and on the northwest coast of the lagoon. The relations have not been fully determined in the area west of Hook Bay, where Upper Jurassic and Upper Cretaceous rocks are known to be exposed, but a great structural unconformity probably exists at that locality. The Eocene sediments (Kenai formation) rest above the Chignik formation. The relationship at this upper contact of the Chignik formation is that of conformity. There appears to have been a long period of sedimentation in this region, extending through late Cretaneous time and nearly to the close of Eocene time, and the nature of the sediments indicate somewhat similar conditions throughout this entire period of deposition. The Chignik formation includes several seams of workable coal interbedded with sandstones, shales, and conglomerates, and in the Kenai formation lignite beds and carbonaceous shales are associated with sandstones, shales, and conglomerates.

Vast quantities of volcanic tuffs and basic lava flows overlie the Chignik formation in the Hook Bay region north of Chignik Bay proper, and at two points in this locality are intrusions of igneous rocks. A large mass of andesitic lava appears to cut across the sedimentary rocks with a fault contact at the southwest terminus of the Chignik formation in this region.

In the Herendeen Bay region the Upper Cretaceous (Chignik formation) appears to rest at some places upon the Upper Jurassic and at other places upon the Lower Cretaceous. The former relationship must be that of unconformity, but the latter may be that of conformity. The data on this problem are not satisfactory. In Pinnacle Mountain (fig. 3), where the section has been examined with some care, Upper Jurassic and Upper Cretaceous horizons have been definitely determined, but there are several hundred feet of sediments in the midst of the section which may possibly represent a portion of the Lower Cretaceous from which no fossils were secured. In the coal field the relationship between the Upper and Lower Cretaceous sediments appears to be that of conformity, but the fossil material obtained in this part of the field indicates a faunal break which may mean an unconformable relationship.

The Kenai formation (Eocene) rests conformably upon the Upper Cretaceous in the Herendeen Bay region. This relationship is shown on the north side of Pyramid Mountain in the central portion of the range, and on the ridge south of Pinnacle Mountain. The conditions of sedimentation in this region appear to have been about the same as those that obtained in the Chignik Bay region during late Mesozoic and early Tertiary times. In Pinnacle Mountain the Chignik formation, along with other sediments, is capped by Recent volcanic tuffs and lava flows (fig. 3). At the eastern margin of the coal field the sedimentary series is covered by great lava flows and by vast quantities of volcanic tuffs. The exposure of the Upper Cretaceous in the central portion of the peninsula midway between

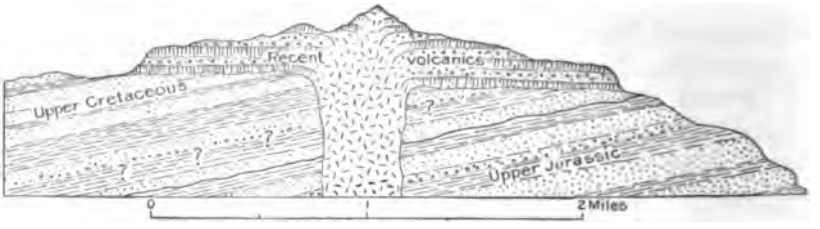


FIGURE 3.—Diagrammatic cross section of Pinnacle Mountain.

Balboa and Herendeen bays is bounded by a fault contact on the northwest, but elsewhere by the conformable series of Kenai sediments.

TERTIARY SYSTEM.

BASALTIC FLOWS, BRECCIAS, AGGLOMERATES, AND TUFFS OF EARLY EOCENE AGE.

This group of volcanic rocks was seen at the eastern margin of the field at the head of Port Moller, and although detailed study could not be made owing to lack of time, it appeared that these rocks corresponded to the "lower beds" of Palache's Stepovak series, examined by him on the south side of the peninsula near the head of Chichagof Cove. If this interpretation is correct, they are of early Eocene age and older than the other groups composed chiefly of pyroclastic rocks to be described later. At the head of Port Moller the volcanic rocks appear to be chiefly basaltic flows. Palache had a favorable opportunity to study these rocks as they are exposed near the base of Chichagof Peak, and the following description is from his report:[1]

The lower beds comprise coarse breccias or agglomerates and fine tuffs composed wholly of igneous material. They show only a rude stratification, but as far as it can be made out it is accordant with that of the overlying, distinctly bedded sediments. The coarser agglomerates contain angular fragments, a foot or less in diameter, of white or greenish porphyry and, rarely, granite. These are cemented sometimes by comminuted material of the same nature, sometimes by a dark greenish black compact

[1] Palache, Charles, Harriman Alaska Expedition, vol. 4, 1904, pp. 74–77.

material which is found, under the microscope, to consist essentially of interwoven hornblende needles. The finer-grained tuffs have a most varied appearance. One specimen is a mass of small angular fragments of yellowish porphyry, the interspaces, largely unfilled, giving the rock a cellular appearance. Again the tuff is compact, with small fragments well cemented. In places the rock is stained bright green by disseminated iron silicates (celadonite?). The impression of these rocks as brought from the field was that they were made up of material of widely varying character. But microscopic study does not confirm this impression. On the contrary, they show in all their phases, and whether the fragments of which they are composed be large or small, considerable uniformity in petrographic character. Most of the sections show porphyritic rocks with a glassy groundmass or with one so indistinctly crystalline as to suggest a devitrified glass. Occasionally the groundmass is a fine granophyric intergrowth of quartz and orthoclase. The numerous phenocrysts consist of acid plagioclase, less abundant orthoclase, and deeply embayed quartz crystals. The feldspars are very fresh and free from inclusions. Magnetite in minute grains seems to be the only other constituent of the rock. The rock fragments seen in the sections range in character from rhyolite to dacite porphyry, with an occasional one of granite.

The cement which binds the fragments together is in some cases clearly secondary silica, but more generally appears to be glass, in which are carried minute feldspar fragments and crystals of quartz, portions of spherulites, and occasionally sharp crystals of zircon and apatite. In one specimen, as mentioned above, the cement is a mass of felted hornblende crystals.

The pyroclastic character of these rocks is certain; in some there is slight evidence of water sorting; others may fairly be called flow breccias. To my surprise, some of them were found to contain fossil shells, for the most part of a pecten-like form. These fossils are too poorly preserved and few to furnish any basis of age comparison with those found in the higher beds. But they establish the fact that some of the tuffs at least are waterlaid deposits, however little the rocks themselves might suggest that conclusion.

Palache's Stepovak series, as defined by him, included these "lower beds" of pyroclastic rocks and a great thickness of overlying strata from which he obtained an abundance of marine invertebrate fossils of Eocene age. During the season of 1908 fossils of Eocene marine invertebrates were secured in close association with the typical Kenai flora, and the formation from which these animal and plant forms was secured was traced to the locality from which Palache secured his collections of fossil shells. These pyroclastic rocks probably indicate local volcanic outbursts early in Eocene time.

EOCENE SERIES.

KENAI FORMATION.

Character and distribution.—The Kenai formation has been recognized at various places on the peninsula and in the northwest portion of Unga Island. Cape Douglas, the northeastern extremity of the peninsula, is composed in part of Tertiary rocks, presumably of Kenai age. The Kenai formation has been definitely recognized a few miles northeast of Katmai and at many places in the Chignik Bay and Herendeen Bay regions, and has been traced over large areas. The formation is known to outcrop on the east shore of Pavlof Bay.

The Tertiary sediments in the northeast part of the peninsula have been described as sandstones, shales, and conglomerates, with some lignite beds. They are exposed near the base of the mountains

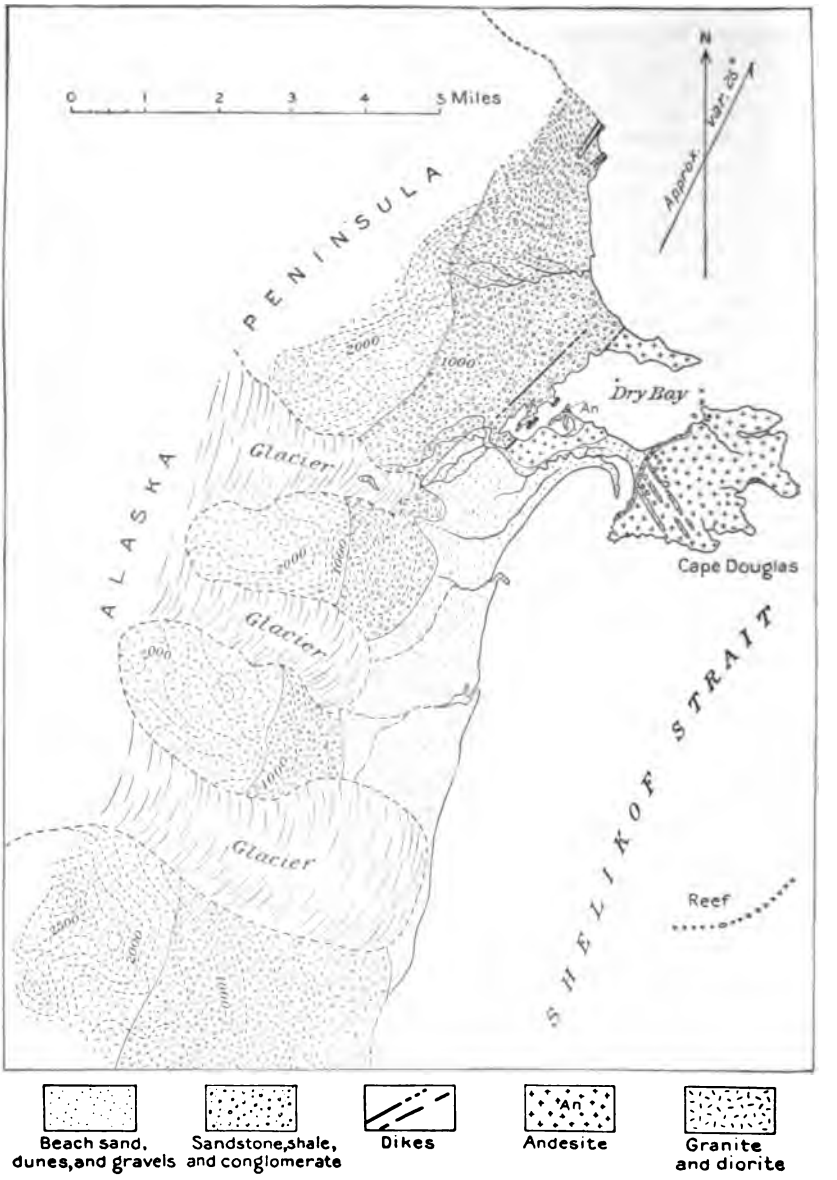


FIGURE 4.—Geologic sketch map of Cape Douglas and vicinity, by R. W. Stone.

west of Cape Douglas and at several points along the shore of that cape (fig. 4). A mass of granitic rock intrudes west of the Tertiary sediments at the northeastern extremity of the peninsula, and suc-

cessive flows of andesitic lava overlie the sediments in Cape Douglas. Between Hello Bay and Amalik there are several small areas of Tertiary rocks presumably of Eocene age (Pl. VI). At Kukak Bay, one of the small reentrants along this portion of the coast, an excellent collection of Kenai plants was obtained by a member of the Harriman expedition. The report on this collection will be referred to later.

The Kenai formation is exposed in the Chignik Bay region on the south side of the bay and southwest as far as Castle Cape, and on the southeastern shores of Chignik Lagoon and Chignik River. (See Pl. VII, p. 40.) There the formation consists of sandstones, shales, and conglomerates, with some thin beds of lignite. The thickness of the formation in the Chignik Bay region is at least 1,000 feet. Near the top of the Kenai section as exposed along the shore of Chignik Lagoon and in the bluff of Chignik River are intrusive sheets, layers of volcanic tuff, and extrusive flows. These igneous rocks become more and more abundant in these localities until the sedimentary record closes and a series of volcanic rocks succeeds.

The Kenai sediments in the Balboa-Herendeen Bay region reach a thickness of at least 5,000 feet and form the main mass of the Aleutian Range. The formation consists of sandstones, shales, conglomerates, and beds of lignite. The sandstones and conglomerates predominate in the lower half of the section and black shales in the upper part. The lower half was commonly spoken of in the field as the alternating series, for its most conspicuous feature was a series of great conglomerate beds ranging from 30 to 50 feet in thickness. This lower portion is well exposed west of the trail in the central portion of the range from Balboa to Herendeen bays. The black shales are shown to the east of the same trail and north of the west arm of Balboa Bay, as well as near the head of Grass Valley, in the central portion of the range, and in Chichagof Peak, at the eastern margin of the area shown on Plate VIII (p. 42). Part of this section was examined by Palache,[1] who used the name Stepovak series in describing the sediments exposed in and near Chichagof Peak.

Where Palache examined these rocks, they were divisible into two parts, which he called "upper beds" and "lower beds." The "lower beds" comprise coarse breccias, or agglomerates, and fine tuffs composed wholly of igneous material. These beds show a rude stratification that appears to be accordant with that of the overlying distinctly bedded sediments. These pyroclastic rocks have been described.

The "upper beds" consist of soft shales, sandstones, and grits, which are the eastward continuations of the strata exposed between Balboa and Herendeen bays. The writer spent but little time during the season of 1908 in this eastern margin of the field, but

[1] Palache, Charles, Harriman Alaska Expedition, vol. 4, pp. 69-87.

observed phenomena seemed to accord with the determinations of Palache, and the mapping in this portion of the field is based in part upon his subdivision of the rocks. The lower or pyroclastic beds are not known to be exposed elsewhere on the peninsula. Volcanic rocks of that nature, so far as they have been studied on the peninsula, are found to be of later age than the Kenai formation. It is quite possible, however, that in the vicinity of Chichagof Peak there were volcanic eruptions in early Eocene time, and that these tuffs and breccias, which have some basaltic flows associated with them, are equivalent in age with clastic sediments elsewhere.

Along the coast west from Balboa Bay the Aleutian Range, constituting the core of the peninsula, appears to be composed of the same great series of Kenai sediments exposed in the Balboa-Herendeen Bay region. An examination of the exposures on the east shore of Pavlof Bay was made, and from those exposures collections of plants and invertebrates were secured. The invertebrates have been judged to be of late Eocene age and the plants of Kenai (Eocene) age. The series exposed on the east shore of Pavlof Bay includes sandstones, shales, conglomerates, and some thin beds of lignite. In physical and lithogical characters these rocks are similar to those elsewhere identified as of Eocene age.

The Kenai formation of Unga Island is limited to the northern and northwestern portion of that island. This locality was visited by Dall in 1685 and at various times since then. Dall has secured collections of fossil plants from the exposures on the west shore of Coal Harbor, and these plants, as determined by Knowlton, belong to the Kenai horizon. The Kenai formation in the island consists of sandstones, shales, conglomerates, and several seams of lignite. The rocks are well exposed on the shores of Coal Harbor, at points along the northwest coast of the island, and thence south along the western shore fully halfway to the southern end of the island. The Unga conglomerate, which is of Miocene age, overlies these rocks conformably on the west shore of Coal Harbor. In the lowland area the Kenai formation is in part mantled by glacial deposits, among which are numerous small lakes or ponds.

Fauna and flora.—The forms determined by Knowlton in the collection of plant material made at Kukak Bay by De A. Saunders are listed below, together with Knowlton's comments.[1]

Plant forms of the Kenai formation.

I. Equisetaceæ:
   1. Equisetum globulosum Lesq.

II. Pinaceæ:
   2. Picea harrimani sp. nov.
   3. Picea, branches.
   4. Picea?, seed.

[1] Knowlton, F. H., Harriman Alaska Expedition, vol. 4, pp. 158-159.

II. Pinaceæ—Continued.
5. Pinus?, leaves.
6. Pinus?, scales of cone.
7. Sequoia heerii Lesq.
8. Sequoia, cone.
9. Taxodium distichum miocenum Heer.
10. Taxodium tinajorum Heer.

III. Juglandaceæ:
11. Juglans acuminata Al. Br.
12. Hicoria magnifica sp. nov.

IV. Betulaceæ:
13. Betula, branch.
14. Corylus macquarrii (Forbes) Heer.
15. Corylus harrimani sp. nov.
16. Corylus? palachei sp. nov.
17. Alnus corylifolia Lesq.
18. Alnus sp.

V. Ulmaceæ:
19. Ulmus braunii Heer.

VI. Aceraceæ:
20. Acer trilobatum var.

VII. Hippocastanaceæ:
21. Aesculus arctica sp. nov.

VIII. Sterculiaceæ:
22. Pterospermites magnifolia sp. nov.
23. Pterospermites alaskana sp. nov.

IX. Ericaceæ:
24. Andromeda grayana Heer.
25. Vaccinium alaskanum sp. nov.

X. Incertæ sedes:
26. Phyllites saundersi sp. nov.

From this it appears that 9 families and 26 forms are represented. Of these families the richest, both in forms and individuals, is the Pinaceæ, to which 9 forms are referred. The most abundant conifer is *Taxodium distichum miocenum*, which is represented by 40 or more pieces of matrix on which there is nothing else preserved, while hardly a piece in the collection is without fragments of greater or less size. The species must have been an important element in this flora, as it undoubtedly was in other arctic floras.

On pages 161 and 162, Knowlton adds:

Of the 26 forms represented in the collection, 9 are described as new to science, 7 are not named specifically, being branchlets, seeds, scales, broken cones, etc., thus leaving 10 species previously known. These are as follows:

Equisetum globulosum Lesq.	Corylus macquarrii (Forbes) Heer.
Sequoia heerii Lesq.	Alnus corylifolia Lesq.
Taxodium distichum miocenum Heer.	Ulmus braunii Heer.
Taxodium tinajorum Heer.	Acer trilobatum var.
Juglans acuminata Al. Br.	Andromeda grayana Heer.

Equisetum globulosum was described originally from Cook Inlet, Alaska, and was also detected by Lesquereux in Fort Union beds near the mouth of the Yellowstone River. *Sequoia heerii* was first found at Sage Creek (?), Mont., in beds of doubtful Green River age. It has since been found in the upper Clarno formation (upper Eocene) at Bridge Creek, Oreg., and is now for the first time reported from Alaska. *Taxodium distichum miocenum* enjoys a very wide distribution but is especially

abundant in arctic lands. Every collection from Alaska contains numerous examples of this species. The closely allied *T. tinajorum* was described originally from Port Graham, Alaska. *Juglans acuminata* was found by Heer at Port Graham also, though first described from the European Miocene. *Corylus macquarrii* has quite a wide distribution, but is especially abundant in Alaska. It has also been reported from the Fort Union beds of Montana and British Columbia, and doubtfully from the Laramie. *Alnus corylifolia* has been reported from Cook Inlet. *Ulmus braunii*, described from the Swiss Miocene originally, has been reported from Kamloops, British Columbia, in strata of probably Eocene age, and from the Green River beds at Florissant, Colo. *Acer trilobatum*, as already pointed out, is too poorly preserved to admit of full identification. A form of this species has been found at Herendeen Bay, but it is not possible to say that they are identical. *Andromeda grayana* was originally made known from Port Graham, Alaska, but has since been rather doubtfully identified from one or two other localities.

From this hasty review it appears that 4 of the 10 species have never been found outside of Alaska, while the remainder are abundantly characteristic of the same region. It is sufficient to state that the named species above enumerated are typical of the so-called "Arctic Miocene," which is now regarded as of the age of the upper Eocene. The species described in this paper as new are in various ways allied to forms characterizing this horizon, and I do not hesitate to refer this collection to the upper Eocene.

No invertebrates were procured from the Kenai formation in the Chignik Bay region, but several collections of fossil plants were obtained. The localities from which these collections were obtained, together with Knowlton's comments on them, are given below:

Collections of plant fauna from the Kenai formation near Chignik Bay.

No. 46. One-half mile south of Northwestern Fishery Co.'s cannery, Anchorage Bay.
Sequoia langsdorfii (Brongn.) Heer.
Sequoia couttsiæ? Heer.
Taxodium tinajorum Heer.
Populus richardsoni Heer.
Age, Kenai.

No. 47. Anchorage Bay, opposite Northwestern Fishery Co.'s cannery:
Populus richardsoni Heer.
Taxodium tinajorum Heer.
Corylus macquarrii? (Forbes) Heer.
Age, Kenai.

No. 48. Anchorage Bay, opposite Northwestern Fishery Co.'s cannery, one-half mile north of 47:
Taxodium tinajorum Heer.
Sequoia langsdorfii (Brongn.) Heer.
Age, apparently same as Nos. 46 and 47.

No. 57. Chignik River, opposite Nun Point:
Sequoia langsdorfii (Brongn.) Heer.
Populus arctica Heer.
Populus sp.
Corylus sp.?
Hedera macclurii Heer.
Magnolia cf. inglefieldi Heer.
Diospyros sp.?
This, I think, is higher than Nos. 54 and 55 and, if the species have been correctly determined, is in the Kenai.

Hollick examined these collections and decided that they were of *Eocene age.*

Dall visited this region in 1871 and collected Kenai plants from the shore of Doris Cove, which is just west of Anchorage Bay.

Kenai fossils have been obtained in abundance from the Balboa-Herendeen Bay region, where the association of the invertebrate and plant material has led to a most satisfactory determination of the Kenai formation. Palache, in 1899, collected a large number of invertebrate fossils from the section exposed along the shores of Chichagof Cove. These were determined and described by Dall, from whose report the following extract is taken:[1]

Dr. Palache's party camped on the eastern side of Chichagof Cove, near the outlet of the lagoon, and the localities where fossils were obtained were noted by him as follows, the number preceding each note being that assigned the locality in our record book:[2]

3373. Beds near the camp on the eastern side of Chichagof Cove, belonging to what Dr. Palache has designated on his sketch chart as the "upper beds" of the Stepovak series.

3374. From the west headland of Chichagof Cove, beds similar to those of 3373.

3375. From the east side of West Cove, the beds belonging to the upper series.

3376. From the hill above the camp, the same horizon as at the camp, but about a mile along the strike.

3377. From slope of Chichagof Peak, beds belonging to the "lower" series of Dr. Palache, near a dike. (See p. 74.)

3378. From the breccia beds of the same lower series as 3377, on the slope of Chichagof Peak.

That some difference in age exists between the beds of the upper series is obvious, but that this difference involves a faunal difference is not so certain, since several of the species found in the lower beds were also collected from the upper beds, and the total number from the lower beds is too small to admit of any valuable comparison being made. If any faunal difference exists, it is probably not greater than that between the Chickasawan and Claibornian horizons in the standard Alabama column, to which we are accustomed to refer our correlations of the Eocene horizons of the east American Tertiaries.

Five species were obtained from the lower beds, one being the *Venericardia planicosta* Lamarck, the well-known "finger post of the Eocene," which, with two others of the five, was also obtained from the upper beds.

An enumeration of the fauna obtained by Dr. Palache now follows.

Invertebrate fossils of the Kenai formation.

Porifera:
- Cliona alaskana Dall.

Mollusca:
- Pelecypoda—
  - Leda sp.
  - Yoldia palachei sp. nov.
  - Yoldia emersonii sp. nov.
  - Yoldia breweri sp. nov.
  - Nucula (Acila) decisa Conrad.
  - Glycimeris sp.
  - Ostrea sp.

[1] Dall, W. H., Harriman Alaska Expedition, vol. 4, pp. 99-111.

[2] The collections, including the type specimens, are in the U. S. National Museum, at Washington, D. C.

Mollusca—Continued.
Pelecypoda—Continued.
Ostrea sp.
Pecten (Chlamys) sp.
Modiolus harrimani sp. nov.
Modiolus sp.
Modiolus alaskanus sp. nov.
Modiolus (Botula?) sp.
Venericardia planicosta Lamarck.
Phacoides? sp.
Macrocallista (Chionella?) gilberti sp. nov.
Macrocallista (Chionella) sp.
Tellina sp.
Spisula callistæformis sp. nov.
Spisula sp.
Mesodesma alaskensis sp. nov.
Gastropoda—
Drillia? sp.
Clavelithes? sp.
Chrysodomus sp.
Rimella? sp.
Cassis sp.
Cerithium? sp.
Crepidula precursor sp. nov.
?Ampullina crassatina Lamarck.
Natica sp.
Margarites peninsularis sp. nov.
Dentalium sp.

The total Eocene fauna of the Stepovak series above described thus comprises at least 34 species, and it is probable that by continued systematic collection a very much larger number might be obtained.

During the season of 1908 several collections of plants were secured in this region from leaf-bearing beds interstratified with sediments bearing Eocene invertebrates. The shell and plant bearing beds where these collections were secured are interstratified, and separated from 10 to 30 feet stratigraphically. The shells are of Eocene age, and the plants are typical of the Kenai strata. The great sedimentary series from which these fossil collections were secured forms the core of the Aleutian Range in this region. These series have been traced eastward, and are found to be continuous with those examined by Palache at Chichagof Cove, from which locality he secured so many typical Eocene invertebrates.

Knowlton's report on the plants from this formation is as follows:

Collections of plant forms from Kenai formation in the Balboa-Herendeen Bay region.

No. 6. One-third mile upstream along strike of beds on south slope of the canyon coming into the head of Balboa Bay from the west:
Sequoia langsdorfii (Brongn.) Heer.
Equisetum globulosum Lesq.
Populus arctica Heer.
Hicoria magnifica? Kn.
Age, Kenai.

No. 10. One-half mile southeast from the head of Herendeen Bay and about 600 feet above the bay:
Sequoia langsdorfii (Brongn.) Heer.
Taxodium sp.?
Osmunda doroschkiana Gopp.
Protorhipis or Hausmannia (n. sp.)
Corylus macquarrii? (Forbes) Heer.
Populus arctica Heer.
Comptonia cf. *C. cuspidata* Lesq. (May be new.)
Age, Kenai.

No. 11. On crest east of divide on trail to Herendeen Bay:
Populus arctica Heer.
Age, Kenai.

No. 20. West side of Herendeen Bay, opposite Marble Point:
Taxodium distichum miocenum Heer.
Taxodium tinajorum Heer.
Populus zaddachi? Heer.
Populus sp.
Populus arctica? Heer.
Hedera macclurii? Heer.
Corylus macquarrii? (Forbes) Heer.
Age, Kenai.

No. 32. Alongshore east of Point Divide between Herendeen Bay and Port Moller:
Nilsonia serotina Heer.
Betula brongniartii Ettingshausen.
Populus artica Heer.
Populus latior Heer.
Acer, probably new.
Zamites sp.
Age, Kenai or slightly later.

Hollick determined the age of the above material as follows: Collections 6, 11, and 20 as "Tertiary-Eocene" and collections 10 and 32 as Upper Cretaceous or lower Tertiary. He writes:

> It is possible that those which I have indicated as "Tertiary-Eocene" may represent a flora identical with that of the upper Yukon Valley and the type locality of the Kenai at Kachemak Bay; but more extensive collections for comparison would be necessary before any positive conclusions on this point could be safely deduced.

If collections 10 and 32 are ever definitely determined to be of Upper Cretaceous age corrections on the geologic map will be necessary.

Two collections of fossil plants were made on the east shore of Pavlof Bay. Only one of them contained identifiable material. In that collection Knowlton recognized the following forms:

Collection of plant forms of the Kenai formation near Pavlof Bay.

No. 44. East shore of Pavlof Bay:
Populus arctica Heer.
Betula brongniartii Ettingshausen.
Ulmus sp.
Juglans sp.
Laurus? sp.
Age, apparently Kenai.

Shells were found in the same section on the east shore of Pavlof Bay, the age of which, Dall says, is uncertain, though the shells appear to be Oligocene or Eocene rather than younger. No new collections of plants were made from the lignite-bearing formation of Unga Island, for the Kenai age of this formation had been previously determined.

Kenai plants have been obtained from widely separated portions of Alaska, including localities in southeastern Alaska, near Eagle, in the upper Yukon district, in the vicinity of Rampart, south of the Tanana Valley in the Ninana River district, on the lower Yukon between Nulato and Holy Cross, and at various other localities less easily designated in the interior and northern portions of Alaska. The type section is exposed on the western margin of the Kenai Peninsula along the shores of Cook Inlet, and from that locality southwest there are numerous small areas from which Kenai plants have been obtained, as well as the large area between Chignik and Pavlof bays described above.

Kenai plants were first thought to be of Miocene age; later they were considered either Eocene or Oligocene. Their Eocene age is now established beyond question. The discovery of marine invertebrates of Eocene age, in close association with typical Kenai plants, in some places on the same slab of rock, is in accord with the Eocene age determination of the plants and a pleasing coordination of the two lines of evidence. Subdivision of the Eocene in this region must await the collection of fuller faunas and floras from different portions of the section and the recognition of the significance of a great many unknown plants that have been and may be collected from this formation.

Stratigraphic relations.—The stratigraphic relations of the Kenai sediments in the northeastern part of the peninsula are not known. In the Chignik Bay region the formation is known to rest conformably upon the Upper Cretaceous and to be covered in part by volcanic rocks. No Miocene sediments have as yet been recognized in the Chignik Bay region.

The Kenai formation is known to rest conformably upon Upper Cretaceous sediments at several points in the Balboa-Herendeen Bay region. This conformable relationship is well shown in the central part of the region, on the north side of Pyramid Mountain; in Pinnacle Mountain, near the head of Herendeen Bay; and in the mountains west of the west arm of Herendeen Bay (fig. 5). In the eastern portion of the field, near Chichagof Peak, the lower Eocene beds have been described as of volcanic origin, but their base is not exposed. The relationship of the Eocene to the Miocene sediments in this portion of the peninsula is that of unconformity. The Miocene beds occur in small isolated areas about the shores, where they appear to rest

on rocks of different ages. The Miocene in the Peninsula has not suffered the same degree of deformation that the Kenai sediments have. Where the Eocene and Miocene sediments come into contact with each other on the west shore of Herendeen Bay distinct contrasts in the dip and strike differentiate the series. The Kenai sediments in the Balboa-Herendeen Bay region have been covered in part by volcanic rocks and have been intruded by vast quantities of igneous material.

In the northwest portion of Unga Island, where the Kenai sediments are well exposed, the base of the formation can not be examined, but Miocene beds overlie conformably the uppermost Kenai sediments. Sedimentation at this place was continuous through later Eocene and into Miocene times. No notable movements appear to have affected the island at the close of the Eocene, but there was slight deformation of the sediments at the close of Miocene time.

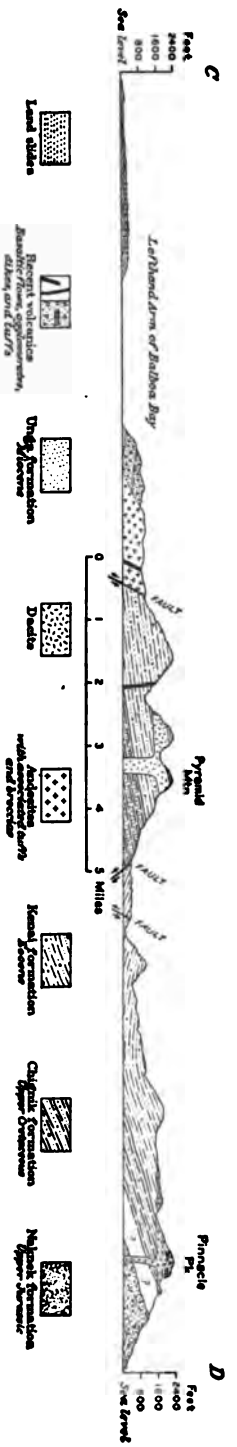


FIGURE 5.—Structure section across the Alaska Peninsula near Balboa Bay, along the line *C-D*, Plate VIII (p. 42).

OLIGOCENE SERIES (?).

No distinct portion of the great conformable series constituting the Aleutian Mountains in the Balboa-Herendeen Bay region can be classed as Oligocene. The invertebrate fossil material in several of the collections has been determined as upper Eocene or Oligocene. Most of the shell material, especially that which was more clearly identifiable, has been determined to be Eocene. All the plants which have been secured from the various beds interstratified with the Eocene shell-bearing horizons have been determined to be of Eocene age.

LATE EOCENE OR EARLY MIOCENE ANDESITES, TUFFS, BRECCIAS, AND GLASS.

Distribution.—In each of the areas studied in detail are considerable masses of igneous rocks composed chiefly of andesites, tuffs, and breccias so intimately intermingled that their separation on the accompanying geologic maps (Pls. VII and VIII, pp. 40 and 42) is impracticable.

The central portion of the island of Unga is largely made up of andesites, which outcrop at a few points along the shore. Popof Island, one of the Shumagin group, which lies nearest Unga to the east, is composed chiefly of volcanic rocks, and andesites similar to those on the Island of Unga are exposed on the southwestern coast for at least 5 miles east of Sand Point. On the mainland in the vicinity of Balboa Bay there is a large but irregularly outlined area in which the principal constituents of the rocks are andesites, associated with volcanic tuffs and breccias. Andesites reach the surface at two smaller areas to the north, in the midst of the range, near the head of Port Moller. The same class of igneous rocks is exposed at the north entrance to Chignik Bay, south of the sedimentary series.

Character.—The andesites in this group of volcanic rocks are commonly dark gray or greenish, with small phenocrysts of feldspar easily visible to the naked eye. In the field these andesites were commonly described as porphyries. At many places, however, the andesites have been so altered as to present various phases of kaolinization, and from these alterations results a dense, flinty-looking matrix of dull white color. Some of the specimens include minerals that have been calcitized or chloritized, and occasionally there are minerals that are slightly epidotized. The outcrops where the rocks have been highly altered usually have deep red or yellow colors, due to the oxidation of the pyrite which is abundantly present in the rocks of those areas. Such an area of altered andesites in the central portion of Unga Island is appropriately named Red Mountain. About this center specimens showing all stages of alterations from the fresh andesites to the kaolin may be collected. A small area of deep red rocks is located about 3 miles east of the head of Balboa Bay. East and south of Red Mountain are large areas of deep yellow pyritized andesites, which have been somewhat altered.

In the Chignik Bay region, south of Chignik Lagoon, this group of volcanic rocks does not show such extreme phases of alteration as in the island of Unga and on the mainland to the north. Here the rocks are dark gray or greenish, with small white feldspar phenocrysts. Where they are locally pyritized they exhibit some discoloration from oxidation. At the north entrance to Chignik Bay the andesitic rock has a dense bluish gray matrix with small feldspar phenocrysts. The microscopic characters of a typical specimen of andesite from the island of Unga by Knopf are given below:

No. 73. Wall rock in the Apollo mine, Unga Island:

Pyritized andesite.—Under the microscope the plagioclase phenocrysts are seen to be partly chloritized and epidotized; others are reduced to an isotropic mineral, probably as opal pseudomorphs. The femic minerals are completely altered to chlorite and epidote, and as indicated by the pseudomorphs, were probably pyroxene. Pyrite occurs scattered throughout the rock in euhedral forms. No magnetite is present. The groundmass is cryptocrystalline, with a greenish tinge from the development of minute chlorite flakes.

A specimen of the andesite taken from the mountain near the head of Balboa shows under the microscope the following characters:

No. 39. From near the summit of the first mountain directly north of Balboa Bay:

Altered andesite.—Microscopically the phenocrysts are found to consist of plagioclase partly calcitized or chloritized and occasionally slightly epidotized, and chloritic pseudomorphs after pyroxene, all resting in a dense ground mass. Accessory magnetite.

These andesites have been broken and crushed, and the recementation in these crushed or sheared zones has resulted in the formation of quartz ledges, some of which are gold bearing. Several such zones of gold-bearing quartz have been located in the southeastern part of the island of Unga, and others have been found on Popof Island and near the head of Mallard Duck Bay, an arm of Chignik Lagoon. A detailed consideration of these gold-bearing zones will be given later in the report.

The volcanic tuffs associated with this group of rocks are interbedded with the flows of andesite and the beds of breccia. These tuffs are composed of small angular fragments, many of which are of andesitic lava, embedded in a brownish groundmass. The accumulation of such tuffs during the period of volcanism varied from place to place, but usually amounted to less than 30 feet in thickness in any one locality. Good exposures of the tuffs occur on the mountain just north of the head of Balboa Bay.

The volcanic breccia included in this group of rocks is also exposed in the mountain north of the head of Balboa Bay, where it appears to be interbedded with the other rocks making up the group. The angular fragments, the largest 4 inches in diameter, are embedded in a dense brownish matrix. The description of the microscopic characters of this rock is as follows:

No. 37. South slope of first mountain north of Balboa Bay:

Altered volcanic breccia.—An altered-looking rock whose derivation is not apparent on inspection. Microscopically shows a clastic texture and consists of porphyritic volcanic fragments. The feldspar phenocrysts are sericitized and calcitized, the carbonate showing sporadically a rhombohedral development. Flecks of limonite are common. The groundmass is cryptocrystalline.

There is a considerable formation of andesitic glass near the southern portion of the island of Unga not far west of the head of Delarof Harbor. This glass shows distinct flow structure. It is light gray in color and in places somewhat porous. Some pitchstone is included within the area mapped as andesitic glass on Plate VIII, (p. 42). The pitchstone, which is exposed near the stream used by the Apollo mine for water power, is of greenish and yellow colors, with a dull waxy luster. The technical description of this andesitic glass is as follows:

No. 2. North slope of Apollo Mountain, Unga Island

Flow-banded andesite glass.—Microscopically, eutaxitic glassy lava containing sporadic feldspar phenocrysts; the flow bands average 1 mm. in thickness and produce a thinly laminated structure. Microscopically, a few feldspar phenocrysts (Ab_1An_2), sporadic prisms of hornblende, and crystals of magnetite are found embedded in a varicolored glass.

The glass appears to underlie the younger basaltic flows and to be closely associated with the andesites which form the central portion of the island. The age of the glass would, if that interpretation is correct, be late Eocene or early Miocene.

Relations to other rocks.—These andesites, tuffs, breccias, and glass appear to be the core of the land mass in the island of Unga, and are probably the oldest igneous rocks exposed on the island. They are unconformably overlain on the eastern shore of the island by Miocene beds which are in turn unconformably overlain by recent basaltic flows and coarse tuffs that rest in places upon this andesitic group. The dactites in this island (Pl. VIII, p. 42) appear to have intruded the andesites. Glacial deposits overlie the andesites in small areas. Eocene rocks outcrop at several places near sea level about the head of Coal Harbor, near which point are outcrops of the andesitic lavas. The relation of the igneous to the sedimentary beds at this point is not known.

On the mainland, in the vicinity of Balboa Bay, these igneous rocks are in part intruded as sills into the Kenai formation and in part overlie that formation. They are in turn manteled unconformably by much younger volcanic rocks of a basaltic nature. Certain dactites, to be described later, have been intruded into this andesitic group at various places. The small areas of andesites in the core of the range in the Balboa-Herendeen Bay region are intrusions into the Kenai formation.

Some andesitic lavas have intruded the Kenai formation, in the Chignik Bay region, and in some places andesites apparently overlie the Eocene sediments in a conformable relationship. The contact west of Chignik River, where the igneous rocks cut off the various sedimentary formations there exposed, appears to have been due to faulting.

Age.—From what has already been stated it is clear that these volcanic rocks are of late Eocene or early Miocene age. In the exposures north of Balboa Bay and at certain localities in the Chignik Bay region, it appears that volcanism began toward the close of Eocene time. The andesitic lava intruded the series of clastic sediments and poured out on the surface. Explosions following the beginning of this volcanic activity yielded fragmental materials that accumulated as tuffs and breccias. These rocks may, therefore, be considered late Eocene or early Miocene, or, perhaps better, transitional—in part, late Eocene and in part early Miocene.

A. PYRAMID MOUNTAIN, NEAR AXIS OF ALEUTIAN RANGE NORTHWE' T FROM BALBOA BAY.

A laccolithic mountain with l :nai sediments at the summit. See page 63.

B. SHORE LINE STACK OR PILLAR ON EAST SHORE OF UNGA ISLAND.

Composed of basaltic lavas and volcanic tuffs. See pages 71, 92.

LATE EOCENE OR LATER IGNEOUS ROCKS.

The igneous rocks included in this class have intruded, in some places, the andesitic rocks just described, in other places the upper portion of the Kenai formation (Eocene), and in one locality the Unga formation (Miocene). They form or are associated with conspicuous topographic features in the Balboa-Herendeen Bay region.

AUGITE PORPHYRY FLOW BRECCIA.

One of the most conspicuous peaks in the Balboa-Herendeen Bay region, about 6 miles west from the head of Balboa Bay, is composed of a flow breccia with the general characters of an augite porphyry. This mountain has sharp pinnacle features that reach an elevation of about 2,500 feet and has been appropriately called Cathedral Peak (Pl. III, *B*, p. 12). The same flow breccia appears in the next mountain east of Cathedral Peak somewhat below the summit, with Kenai sediments above and below. The igneous rock is high in the Kenai section, and therefore of late Eocene age.

Knopf's description of this rock is as follows:

> In the hand specimen the vitreous brown augites embedded in an aphanitic brown matrix are the most conspicuous feature. Microscopically it proves to be a glassy augite porphyry flow breccia containing numerous fragments of various kinds of andesite. Considerable chloritization has affected the rock.

DACITES.

Distribution.—Dacites are exposed in several areas on the island of Unga and on the mainland in the Balboa-Herendeen Bay district (Pl. VIII, p. 42). The areas on the island of Unga are in the south portion of the island within a few miles of the village of Unga. On the mainland to the north the dacite exposures are in the higher peaks just west of the trail between Balboa Bay and Herendeen Bay. Other masses of dacite have intruded the sedimentary rocks southeast of Herendeen Bay and still other small areas occur on the Pacific coast east of Balboa Bay.

Pyramid Mountain is located in the central portion of the peninsula southwest of the head of Balboa Bay. It is a conspicuous snow-capped peak (Pl. IX, *A*) and rises to an elevation of about 2,500 feet. The main mass of the mountain is composed of the Chignik and Kenai formations (fig. 6). Near the summit, except for the upper 100 feet, which consists of Eocene sediments, the mountain is for the most part dacite.

The dacite exposed in Pyramid Mountain is part of a large laccolithic mass, from which outliers extend westward, forming the crests of two mountain ridges. A large amount of dacite was removed in the development of the valley between these mountain ridges. The dacite attains a maximum thickness of about 1,000 feet near Pyramid Mountain, from which point the mass becomes gradually thinner in all directions.

The dacite mass west of Santiago Bay forms a somewhat conspicuous mountain of light-gray color. The masses of dacite farther east appear to have intruded the andesitic lavas and tuffs, and the mass bordering the coast appears as a great intrusive sheet. The area a little back from the coast forms a conspicuous knob 2,000 feet in height.

Of the dacite areas in the southeastern portion of Unga Island, those bordering the coast appear as bold cliffs that weather to a light gray color. The areas inland form low knobs along the crest of the mountain ridge. Dacite-like lavas have been seen in the Chignik Bay region, but the mapping has not been carried out in sufficient detail to differentiate those masses from the dacite proper.

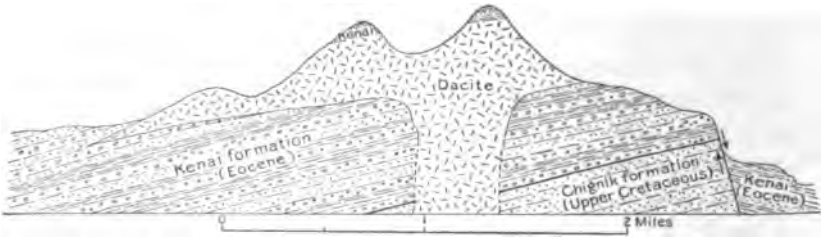


FIGURE 6.—Diagrammatic section of Pyramid Mountain.

Character.—The dacites have a porphyritic texture, with dull white phenocrysts of feldspar and glassy quartz in a gray or light greenish groundmass. The microscopic description of a specimen taken from the large laccolith in the central portion of the range northwest of Balboa Bay is as follows:

No. 53. From Pyramid Mountain laccolith (Pl. VIII, p. 42).

Dacite.—Microscopically, the quartzes are found to be powerfully resorbed, the plagioclase Ab_1An_1 to show marked zonal banding, and the hornblende prisms are in places chloritized. The alteration of the rock as a whole, however, is unimportant. The groundmass is unusually well individualized for these volcanics; it consists of small stout plagioclases and interstitial quartz and probably some orthoclase. The accessories are magnetite, apatite, and titanite.

Relations to other rocks.—On the mainland the intrusions of dacite are in the form of sills, dikes, and laccoliths; the structural relations in the large laccolith northwest of Balboa Bay are shown in figure 6. The mass of dacite is about 1,000 feet thick and extends over an area of several square miles. Remnants of the sedimentary formations overlie the igneous rock in two of the higher peaks (Pl. VIII). The large mass of dacite in the central portion of the range and east of the head of Herendeen Bay is not so clearly shown to be of laccolithic form. This intrusion is also into the Kenai formation. East of Balboa Bay along the coast and in the southern portion of Unga Island the dacite masses appear to have intruded the andesites described above.

Age.—It appears from the evidence just presented that the dacites are all late Eocene or later, for they cut late Eocene sediments and late Eocene or early Miocene volcanics at several places. At the head of Port Moller dacites cut and overlie Miocene sediments. They are probably all older than the basaltic flows and tuffs soon to be described.

DIORITE PORPHYRITE.

The determination of this rock was made by Palache. The only known exposure of this type of igneous rock is in the Chichagof laccolith (fig. 7). Chichagof Peak reaches an elevation of a little more than 3,000 feet. It is about 4 miles northeast from the head of Chichagof Cove and near the eastern margin of the area shown on

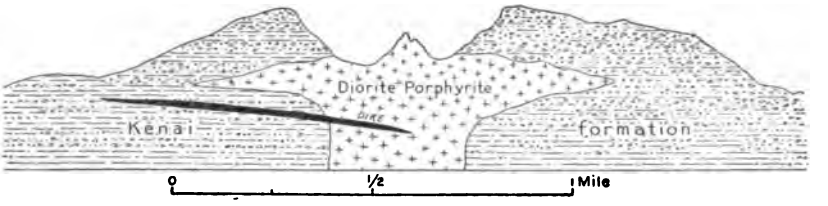


FIGURE 7.—Diagrammatic section of south face of Chichagof Peak. After Palache.

Plate VIII (p. 42). The main mass of the mountain is composed of the Kenai formation. Near the base there are several hundred feet of volcanic tuffs and breccias, and the laccolithic mass here referred to and shown in figure 7 is near the summit. The rock ranges in color from gray to greenish gray and has a distinctly porphyritic texture. Palache states that the intruded rock is well exposed near the summit of Chichagof Peak, and that dikes are numerous in the vicinity of the laccolithic mass. The dikes are reported to be in a general way radial to the dome-shaped uplift of the peak, and hence to cut across the strike of the sedimentary beds at high angles. The description of one of the microscopic sections, by Palache,[1] is as follows:

Diorite-porphyrite.—Grayish green rock with many stout prismatic green hornblende crystals, in fine gray matrix, which stand out on weathered surface. Groundmass of minute green hornbrende needles and basic plagioclase microlites less in amount. Phenocrysts labradorite and hornblende. Labradorite very abundant in sharply bounded crystals, twinned on albite and Carlsbad laws, very fresh and free from inclusions. Hornblende colorless to pale green, fibrous, in short stout sharply terminated crystals, sometimes inclosing a small core of colorless pyroxene, but clearly original. Chlorite almost the only decomposition product, replacing some of the groundmass hornblende. Quartz is absent.

[1] Palache, Charles, Harriman Alaska Expedition, vol. 4, p. 80.

MIOCENE SERIES.

UNGA FORMATION.

Character and distribution.—Dall gave the name Unga conglomerate to the sediments of Miocene age which he examined on Unga Island. At that locality the formation is predominately conglomeratic, but at the many other localities indicated on the maps accompanying this report the formation does not include much conglomerate, and accordingly the term Unga formation is used here. This formation was first recognized by Dall [1] in the western portion of

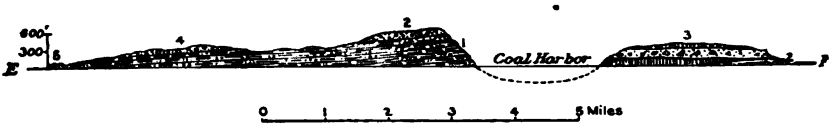


FIGURE 8.—Structure section at the north end of Unga Island, along line *E-F* on Plate VIII. 1, Kenai formation (Eocene); 2, Unga formation (Miocene); 3, recent volcanic rocks, basaltic flows, and tuffs; 4, glacial drift; 5, sand dunes.

Unga Island, where it overlies the Eocene lignite-bearing beds (fig. 8.) At this locality Dall measured, in 1872, the following section:

Measured section of the Unga conglomerate on Unga Island, Alaska.

[Section includes 200 feet.]

1. Tuffs and soil.
2. Conglomerate of fine pebbles.
3. Conglomerate of larger bowlders.
4. Sandstone with marine fossils (1 foot).
5. Thin friable sandy shales (6 inches).
6. Conglomerate like No. 2.
7. Very coarse conglomerate (2 feet).

On the following page Dall, in describing the formation, states:

In the conglomerate (Nos. 6 and 7) many pieces of rolled silicified wood were found, some of which were bored by teredos. These beds are evidently a beach formation, presaging the depression which followed in which the marine bed above them was laid down. I have called them the Unga conglomerates; and the marine stratum, which will be referred to later, from the great abundance of *Crepidula proerupta* Conrad, I have called the *Crepidula* bed. It conformably overlies the others, and there can be no doubt of the continuity of the sedimentation through the whole series of lignitic and marine strata in this locality.

The conglomerates in this type section contain large quantities of volcanic fragments which do not appear to be water worn, and therefore suggest eruptions in the immediate vicinity during a period of sedimentation.

Miocene sediments have now been found at several other localities. They are exposed on the northeast shore of Unga Island, on the northwest coast of the island of Popof, at several points on the shores of Balboa Bay and the Pacific side of the peninsula near that bay, on the west shore of Herendeen Bay and along the margin of Port Moller.

[1] Dall, W. H., Coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, p. 807.

At each of these localities the Miocene appears to be limited to a small area, except on the northeast shore of Port Moller, where it is at least 1,000 feet thick and appears to extend for some distance north and east of the exposed face. It is possible that it will be found to be overlain in that direction by Recent volcanics. The exposures at the west entrance to Balboa Bay and on the west arm of that bay suggest by the nearly horizontal position of the strata that they underlie Cape Aliaksin, an island-like mass now tied to the mainland by an alluvial deposit (Pl. VIII). At each of the localities in the Balboa-Herendeen Bay region and on the island to the south the formation consists of sandstones, shales, and conglomerates, some of which are but loosely cemented. In the exposures along the shore of Port Moller the rocks consist of sandstones, many of which show cross-bedding, shales, grits, and conglomerates containing pebbles of quartz, flint, basalt, greenstone, and porphyry. This series has a fossil stratum carrying an abundance of oyster shells. Dikes and sills of a porphyritic basalt have intruded the Miocene section along the shores of Port Moller.

The section on the south side of the west arm of Balboa Bay is as follows:

Section of Miocene sediments near Balboa Bay.

	Feet.
Shales with sandstone concretions	50
Sandy shale with sandstone concretions	40
Sandy clay with concretions	30

This section is exposed for about 3 miles along the beach. The upper surface has been worked over by the waves and shows a distinct sea terrace about 100 feet above mean tide. The formation includes seams of lignite 2 to 3 inches in thickness. These lignite stringers occur locally in the form of lenses. The beds dip gently to the south, passing below heavy beds of volcanic tuff. Leaf fragments and bits of carbonized wood are included in some of the sandstone blocks which have fallen from the cliff, and worm tracks are abundant in some of the sandstone layers.

In the small area of probable Miocene on the west side of Herendeen Bay the sediments are for the most part unconsolidated. They yielded one-leaf collection which has been determined to be of post-Kenai age, and since the physical nature of the beds and the general field relations are similar to those in the known Miocene areas, this small area has been considered of Miocene age.

The small area of Miocene sediments on the east side of Balboa Bay is about 200 feet thick. The beds consist of clays, sandy clays, grits, sandstone, concretions, one 4-foot bed of heavy sandstone, and some carbonaceous shale. Some leaf fragments and bits of carbonized wood were seen, but no specimens suitable for identification were obtained. At this outcrop the dip varies from 5° to 15° to the southward, and the strike is west 15° south. The Miocene

beds in this locality have been beveled by the action of the waves at 50 and 100 feet above mean tide, at which elevations are remnants of sea terraces.

Fauna.—Shells have been found in abundance at all but one or two of the localities mapped as Miocene on Plate VIII (p. 42). These shells have been submitted to Dall, who, although he has not reported the specific names of the fossils, has recognized them as of Miocene age. In commenting upon the collections secured from the northeast corner of Unga Island and the northwest shore of Popof Island, he calls them "Upper Eocene, corresponding to the Unga horizon." The collection secured from the north side of the left arm of Balboa Bay "appears to belong to a horizon near to, or identical with, that of the Astoria beds, Oregon." The collection from the northeast side of Port Moller "indicates the Unga horizon containing *Mytilus middendorffii* Grewingk and other characteristic species." The collection from the west side of Santiago Bay is determined to be

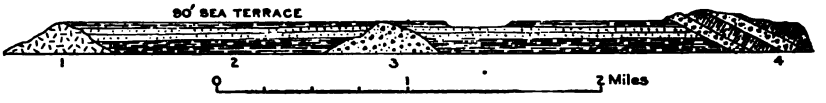


FIGURE 9.—Structure section along the northeast coast of Unga Island. 1, Andesite; 2, Unga formation (Miocene); 3, tuffs; 4, recent basalt flows and tuffs.

Miocene. An impression of a bivalve secured from the mainland just north of Unga Island was determined as "probably *Marcia oregoneus* Conrad from the Astoria horizon of the Miocene."

Flora.—One collection of plants determined by Hollick to be probably of Miocene age was recovered from a small area of partly consolidated sediments on the west side of Herendeen Bay, about opposite Marble Point.

Stratigraphic relations.—As has been already stated the Miocene in the northwestern portion of Unga Island rests conformably upon the Eocene (fig. 8, p. 66). There is a scattering of glacial drift over the surface, but otherwise the formation is not covered at this locality. Along the northeast coast of Unga Island the base of the formation is exposed at one or two points (fig. 9) where the andesitic group of volcanic rocks come above sea level. At this locality the formation is clearly overlain unconformably by recent basaltic flows and coarse tuffs. Conditions similar to those in the northeast portion of Unga Island prevail in each of the Miocene areas near Balboa Bay and west of Santiago Bay. The base of the formation is not exposed, but the overlying rocks are volcanic tuffs, which rest unconformably upon the little disturbed clastic sediments. The small area, probably of Miocene age, on the west shore of Herendeen Bay, is unconformably related to the Jurassic and Cretaceous sediments at the south. At the north the relationship to the Eocene is either due to an unconformity or to faulting.

The base of the series was not recognized about the shores of Port Moller. Andesitic lavas cut through and overlie a portion of the Miocene area at the south end of Port Moller and glacial drift mantles another portion. Farther east the Miocene comes into contact with volcanics along what is believed to be the fault plain. The upper surface of the Miocene was not examined northeast of Port Moller, but from a distance the formation appears to be overlain unconformably by volcanic rocks.

At no one of the localities are the Miocene beds much disturbed. They are nearly horizontal or occur in gentle folds. In the northern portion of Unga Island the base of the formation varies in elevation about 500 feet in a distance of 5 miles (fig. 8, p. 66). The Miocene beds on the peninsula have undergone much less deformation than the Eocene beds, and except at a few localities the Miocene probably rests unconformably on formations older than Eocene.

POST-MIOCENE BASALTIC FLOWS AND TUFFS.

Distribution.—In this class are included the great masses of recent volcanic rocks consisting chiefly of basaltic flows and coarse volcanic tuffs. Such rocks have been reported from all parts of the peninsula that have been visited by geologists. Spurr refers to the axial portion of the Aleutian range in the northeastern part of the peninsula as composed of Tertiary-Quaternary volcanic rocks (Pl. VI, in pocket). He reports also that in this chain of mountains as seen by him in crossing from Naknek to Katmai there are several volcanic peaks, some of which have been recently active. In the Chignik Bay region are vast quantities of coarse black volcanic tuffs in the vicinity of Hook Bay (Pl. VII, p. 40), and the basaltic dikes of this same period of volcanism cut through formations in this region at various places. A large portion of the island of Unga is mantled by volcanic tuffs and recent basaltic flows. North of Unga, in the Balboa-Herendeen Bay region, recent volcanic rocks occur in various portions of the field (Pl. VIII, p. 42). They are conspicuous about the shore of Balboa Bay and eastward. The summit of Pinnacle Mountain near the head of Herendeen Bay is composed of volcanic tuffs and recent basaltic flows (fig. 3, p. 48). An area of nearly 100 square miles extending southward from Hot Springs on the west side of Port Moller is covered by recent volcanic rocks of the same nature as those just described. Westward from Pavlof Bay the peninsula and neighboring islands are reported to consist wholly of recent volcanic rocks.

Character.—When seen from the beach or from a boat while coasting along the shore these tuffs appear to be composed of black and dark brown fragments in a matrix of about the same colors, but when a hand specimen is examined the matrix is commonly seen to have a dark green color. The fragments included in this tuff

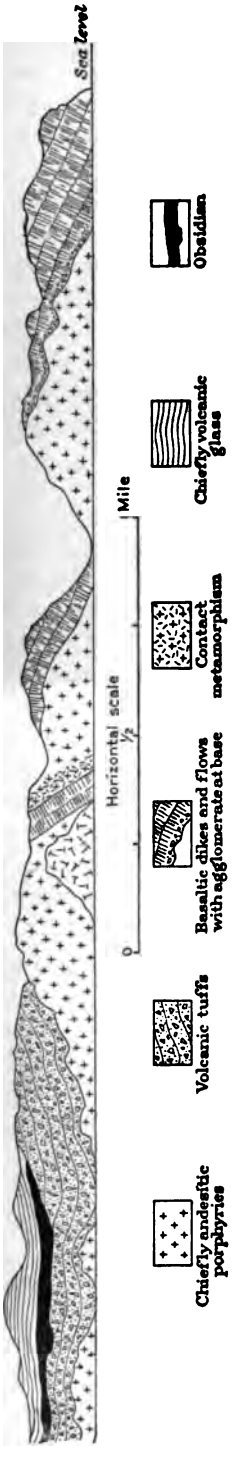


FIGURE 10.—Diagrammatic section along east shore of Unga Island south of Baralof or Squaw Harbor.

range up to 20 feet in diameter; commonly their dimensions vary from 3 to 6 feet (Pl. X, *B*). Individual blocks display the darker shades of red, green, and gray. Some of the blocks are distinctly black, and all of them show a scoriaceous texture. The tuff is poorly stratified, but appears to have been in part, at least, laid down in water. One marine shell found in the tuff just west of Balboa Bay has been identified by Dall as of Miocene age, but some uncertainty exists as to whether this shell was washed from the Miocene sediments into the sea when the tuffs were being deposited or whether the shell was left by a form living in the waters when the tuffs were laid down. Several volcanic centers associated with these recent tuffs and flows have been located. Volcanic tuffs and associated basaltic flows reach a thickness of at least 1,200 feet on the west shore of Balboa Bay.

Relations to other rocks.—Sections on the northeast corner of Unga Island show clearly that these tuffs are younger than the Miocene sediments, on which they rest unconformably (fig. 9, p. 68). The exposures in the recent volcanic tuffs and basic flows about the shores of Unga Island exhibit complex relationships which, when worked out in detail, will reveal a remarkable history of volcanism for this island. The diagrammatic section given in figure 10 shows the more easily apparent conditions along the east shore between Delarof and Baralof harbors, which is included in the view shown in Plate V, *B* (p. 38). In this section is the small mass of argillite of unknown age already described, as well as areas of the older volcanic series of the island, which are at this locality chiefly andesitic porphyries. The upper surface of this older series of volcanics has certainly been modified by erosion, and at the base of the new series, in places, volcanic agglomerates occur. The later series includes vast quantities

A. ELEVATED SEA TERRACE AT NORTHEAST END OF UNGA ISLAND.

Miocene beds are exposed in the cliff below the terrace level. See page 66.

B. DETAILED VIEW OF COARSE VOLCANIC TUFF OF POST-MIOCENE AGE AS EXPOSED ON SHORES OF BALBOA BAY.

See page 70.

of tuffs, which are remarkably well bedded. Locally they are much deformed. A considerable amount of volcanic glass is associated with the younger volcanics exposed in this cliff, and local metamorphism has taken place where basaltic masses have intruded the earlier andesitic rocks. Since the cessation of volcanism in this part of the island, stream erosion has developed new valleys that have been lately modified by ice action, and the waves have been actively at work modifying the coast. The rock pillar shown in Plate IX, *B*, is composed of recent volcanic rocks. This pillar has been separated 300 feet from the main cliff by the work of the waves.

The recent volcanic rocks on Popof Island appear to rest upon a very uneven surface. This unevenness presumably resulted from a period of erosion after the close of Miocene time and before the renewal of volcanic activity that brought these rocks to the surface. Recent volcanic rocks clearly overlie the Miocene at several places on the mainland north of Unga Island. On the north side of the peninsula, near Herendeen Bay and Port Moller, they rest on the eroded surface of various Mesozoic and Tertiary formations. The youngest sediments upon which they are known to rest in this portion of the field are of Eocene age, but they will probably be found to overlie the Miocene east of Port Moller. The most recent volcanic rocks in the Chignik Bay region come into contact with the Upper Cretaceous (Chignik formation) near the north entrance to the bay. They are clearly younger than the Chignik formation, but basaltic dikes that are believed to be of the same age cut Eocene sediments in the vicinity of Chignik Lagoon.

Age.—These volcanic rocks are chiefly of post-Miocene age, and may all be post-Miocene. In the region studied they are, for the most part, pre-Pleistocene, but it is certain that similar formations are to-day accumulating about the active volcanoes.

PLIOCENE SERIES (1).

A small area of sediments on the west shore of Herendeen Bay, which has been classed and represented on the map (Pl. VIII, p. 42) as Miocene, yielded a collection of plants which, though not satisfactory for close determination, were judged by Knowlton to be of Miocene or Pliocene age, and since there were several similar small areas of Miocene beds bordering the coast, this area has been tentatively classed with them. The possibility remains, however, that there are some sediments of Pliocene age at that locality.

SUMMARY OF THE IGNEOUS ROCKS.

The igneous rocks thus far known in the Alaska Peninsula may be grouped in two classes. In one of these should be placed the coarsely crystalline rocks in Mount Douglas and in the northwestern

part of the peninsula, west of Becharof and Naknek lakes. These rocks have been described as granites and syenites. They are certainly pre-Upper Jurassic, and from data obtained just beyond the limits of the peninsula it appears that they are Lower or Middle Jurassic. The full extent of these rocks is not yet known. The Mount Douglas area is probably limited to a small group of peaks at the northeast terminus of the peninsula. The igneous rocks at the extreme northwest outcrop in a belt roughly parallel to the axis of the peninsula, and probably extend for more than 100 miles in a northeast-southwest direction.

The other group of igneous rocks is chiefly of volcanic origin. These rocks include basaltic and andesitic flows, breccias, some volcanic glass, and vast quantities of tuffs. Near the volcanic centers dikes, sills, and laccolithic intrusions are exceedingly common. The rocks in this class are of Tertiary or later age. They are irregularly distributed from the northeast extremity of the peninsula, at Cape Douglas, to the western terminus near Unimak Pass and are the predominant formations in the neighboring islands. Where detailed mapping has been done these volcanic rocks have been found to be in part of early Eocene age, in part of late Eocene or early Miocene age, and in part late Miocene and post-Miocene. In fact, the association of these igneous rocks with the Tertiary and Quaternary sediments is such as to indicate that volcanic activities have probably been continuous in this portion of Alaska since the beginning of Tertiary time.

The earliest of the Tertiary lavas have been considerably metamorphosed. Later Tertiary lavas appear exceedingly fresh, while some lavas of Quaternary age are unconsolidated fragments that have very recently issued from volcanic vents. The metamorphism of the earlier Tertiary lavas has changed in a most notable degree the colors and physical properties of these rocks. Large areas of these lavas are colored in brilliant reds and yellows, and at other places the weathered material is a dull white. Knopf has drawn the following general conclusions from a microscopic study of specimens of these weathered lavas:

In many of the volcanics the alterations represented by chloritization of the ferromagnesian minerals and kaolinization of the feldspars are such as are produced by simple weathering; in others, however, the alteration has taken on a propylitic aspect, as first noted by Becker at Delarof Harbor.

The most intense alteration is shown by the pyritized andesites. In them the ferromagnesian minerals have been converted into chlorite and epidote, the feldspars have been replaced by calcite and partly epidotized, and a more or less thorough alteration has affected the ground mass. Pyrite occurs scattered throughout the rocks and is embedded in both primary and secondary minerals. There has, however, been no great introduction of new material. The iron originally contained in the femic minerals and in the magnetite was sufficient to supply that necessary for the production of the pyrite. Carbon dioxide and hydrogen sulphide appear to have been the main

agents of alteration. The calcitization of the plagioclase feldspars implies necessarily that there has been an elimination of soda from the altered andesites.

Several vents beside the active volcanoes in the peninsula have but recently been scenes of great activity. Fragmental materials lie about each of them in vast quantities and a further study of the geology of the peninsula will undoubtedly show numerous other areas where volcanic rocks have been poured out on the surface and widely distributed by explosion. Many of the headlands bordering the Pacific Ocean owe their resistance to firmly cemented pyroclastic rocks, while others that well resist the action of the waves are composed of the denser andesitic flows that have issued from neighboring volcanoes.

QUATERNARY SYSTEM.

PLEISTOCENE DEPOSITS.

Character and distribution.—The Pleistocene deposits consist of unconsolidated clays, sands, gravels, and glacial drift. Quantitatively the glacial drift is perhaps chief in importance among these deposits. The distribution of glacial drift in the areas studied in detail during the summer of 1908 is shown on Plates VII and VIII (pp. 40 and 42). It was impracticable in the mapping to indicate the distribution of glacial bowlders, or a mere scattering of glacial drift in the valleys, but the extent of the larger masses that mantle or obscure the underlying formations has been indicated on the maps. Pleistocene deposits have not been studied in detail elsewhere on the peninsula, and from the various reports that have been given it would appear that such deposits are not conspicuous. It is probably safe to infer that there is more or less glacial drift associated, as a mantle, with the northwestern lowland of the peninsula. Such was found to be the case in the lowland area bordering Herendeen Bay, where there is a mantle of glacial drift from 10 to 30 feet thick. In the western and northwestern portion of the Island of Unga several square miles are mantled by glacial drift, and morainic deposits occur in certain of the larger valleys. In the discussion of glaciation that will be given later in this report it will be shown that most, if not all, of Unga Island has been glaciated, and that a little glacial drift may be expected almost anywhere in the lowland portions on the island.

On the mainland north of the peninsula there are but small patches of glacial drift associated with the mountain areas. The only considerable areas where there are glacial deposits are on the north side of the peninsula, bordering Herendeen Bay, and at the head of Port Moller (Pl. VIII, p. 42).

Small patches of glacial drift occur in the interstream areas northwest of Chignik Bay (Pl. VII, p. 40), others on the shores of Chignik

Lagoon, and at least two small patches near the east end of Chignik Lake. The work in this region could not, in the time available, be carried far from the shore. It is quite probable that there is much more glacial drift in the valleys northwest of Chignik Bay and on the lowlands bordering the range to the northwest.

At each of the localities specified the drift has the physical heterogeneity characteristic of glacial till, and as there are in all the parts of the peninsula and the neighboring islands that have been studied many varieties of rocks the drift has a striking lithologic heterogeneity. Many of the stones are smooth and striated, and the material is for the most part unassorted.

The topography of these glacial deposits is of two types. On the lowlands the surface of the drift contains numerous undrained depressions bordered by low moundlike hills. It has the typical rolling topography of the ground moraine left by continental ice sheets over lowland areas. In many of the depressions are ponds or small lakes; in others are swamps, the remnants of former lakes. In the mountain valleys the deposits are distributed as lateral or medial moraines, and commonly have a ridgelike form characteristic of mountain valley moraines.

Stratigraphic relations.—The Pleistocene deposits rest upon upturned and eroded sedimentary rocks that range in age from late Jurassic to Miocene, and upon still younger volcanic formations. It is probably true that the outwash from certain of the glaciers that formerly existed here rests conformably between a series of offshore deposits of Quaternary age, but such deposits can not yet be studied.

The glacial drift in the regions mapped in detail by the author is probably all of Pleistocene age. The ice certainly left the lowlands, and quite probably the basin regions, about Chignik Bay, Unga Island, and Herendeen Bay, long before the occurrence of the last notable movement, which elevated the lands of the peninsula and adjoining islands at least 100 feet above sea level. Elsewhere on the peninsula glaciers lingered long after Pleistocene time and among the higher mountains, especially at the extreme northeast, even until the present time. There is, therefore, post-Pleistocene glacial drift in the peninsula, and further studies in this portion of Alaska may determine criteria for distinguishing the Pleistocene from the post-Pleistocene glacial deposits.

Topographic relations.—The morainic deposits are on the side slopes at some places in the valleys. Many of these deposits are at the junction of a tributary valley with the main valley and rest upon the dividing ridge, partly as lateral moraines, and, where they have united, as medial moraines. One remarkable glacial moraine on a high ridge separates two large valleys in the western portion of

Unga Island and forms in that place the crest of the ridge. This fact indicates that most of the western portion of the island was under ice at the time the moraine was deposited. The greater part of the glacial drift, however, is in the lowlands, where the valley glaciers deployed and where the conditions for deposition and for preservation have been more favorable. General conditions during the Pleistocene epoch and the work of the glaciers in the different regions studied will be described later.

RECENT DEPOSITS.

Pumice.—Fragments of pumice have been seen in two localities on the north side of Chignik Bay, one of these localities being in the valley of Bear Creek, where there is a considerable deposit. The fragments range up to 6 inches in diameter. This deposit appears in a small knoll or short ridge in the bottom of the valley, and must have been formed since the main valley was excavated. The source of this material may have been within the area to the east mantled by recent volcanic rocks, and where volcanic centers have been located. The other locality where pumice occurs is about 2 miles from the head of Hook Bay on the mountain southwest from the harbor. These mountains are of volcanic origin and some fragments of pumice are associated with the vast quantities of fragmental material about them.

Alluvium.—Deposits of Recent alluvium, which consists of unconsolidated sands, clays, and gravels, occur in the valley bottoms and along the shores. In the areas where mapping has been done in detail (Pls. VII and VIII, pp. 40 and 42) it is noticeable that at the head of each bay and in the lower part of each of the larger valleys there are bottom lands mantled by Recent alluvial deposits. These deposits have the forms of great flood plains and bayhead deltas.

Along the shores the Recent deposits take the form of sand bars, sand spits, hooks, or barrier beaches. They consist of sands and gravels worked over by the waves and distributed along the beach by waves, undertow, and shore currents. Hook Bay (Pl. VII, p. 40), north of Chignik Bay, has received its name from a sand and gravel deposit. Prospect Bay (fig. 18) owes its harbor to a sand and gravel hook developed there by the action of the waves and currents. Chignik Lagoon is but the upper end of Chignik Bay, shut off in part by a sand spit. Doris Cove is nearly closed by a sand spit, and Anchorage Bay (Pl. XI, *B*, p. 86) is protected by a similar form. Sand Point, on Popof Island, is appropriately named. The head of Santiago Bay is nearly closed by a sand bar, and Chichagof Cove has been shortened by the development of a barrier beach. Alluvial sediments extend upstream in all the larger valleys until they reach an elevation of about 100 feet above

sea level. Distinct marine terraces too small to be indicated on the map appear along the shores of the mainland and of the islands at about 100 feet above sea level, and upon these terraces are Recent alluvial deposits. In places such deposits include glacial material that has been worked over by the waves. The terraces indicate unquestionably that the water stood about 100 feet higher relative to the lands in very recent time, and that during that period the alluvial lands at the heads of the bays and in the larger valleys were covered by marine waters. Since the uplift of the land the sea terraces have been somewhat dissected by streams, and in places mantled by wash from higher lands. The heads of the bays gradually uncovered by the rising of the land have come to be bottom lands of the larger valleys, and the alluvial material brought by the streams has been spread over them.

Landslides.—At a few places on the shores of Balboa Bay large areas have been so affected by landslides that it would be difficult, if not, indeed, impossible, to find exposures of the underlying rock formations. These localities have been indicated on the map as landslide areas. Landslides have occurred at many other places, but not to such an extent as totally to obscure the underlying geology, or to demand recognition on the areal map. The cliffs that have yielded most readily to the development of landslides are composed of volcanic tuffs. The areas on the west arm of Balboa Bay are developed where Recent volcanic tuffs are underlain by soft and only partially consolidated Miocene sands and clays, a condition very favorable for the development of landslides.

Sand dunes.—On the northwest shore of Unga Island, at one point on the east side, and on the coast of the mainland north of Unga Island, are sand-dune areas of sufficient extent to be indicated on the map. Dunes are also common along the Bristol Bay coast line and southwest along the shore of Bering Sea.

Glacial drift.—There are certainly glacial drift deposits on the peninsula of post-Pleistocene or Recent age. They may be expected among the higher mountains in the northeast portion of the peninsula and on the slopes of some of the volcanic peaks at the extreme southwest.

GEOLOGIC HISTORY.

From the nature and distribution of the sediments, as now known, some inferences may be drawn as to the distribution of land and water at different times in the history of the peninsula. The structure and structural relations indicate the geologic periods in which deformation took place, and the relations of the igneous rocks to the sedimentary rocks indicate the periods of volcanism and mark phases of intrusion, extrusion, and volcanic outbursts.

EARLY MESOZOIC TIME.

The granitic rocks in the northern portion of the peninsula that are known to be of pre-Upper Jurassic age, the report of similar rocks on certain of the islands in the Shumagin group, and the conglomeratic and arkosic nature of the Upper Jurassic sediments all indicate that in early Mesozoic time masses of coarsely crystalline igneous rocks were exposed in parts of the peninsula, at least.

The Triassic rocks, which are limited so far as is now known to a small area on the southeast side of the peninsula and near the northern line, consist chiefly of sandstones, limestones, and shales. The limestones and the shells they contain indicate that the waters were shallow and marine, and at times clear. The clearness of the waters during the limestone-making periods shows either that there was little or no land near, or that the land was very low and therefore yielded little detrital material for streams to carry to the sea. The shales indicate that the waters became muddy at times, perhaps from quickening of stream work due to a slight uplift of neighboring lands, or possibly from the formation of new lands. The Upper Triassic beds have not been found in contact with any older rocks, and are consequently the most ancient rocks known in the peninsula. During a period of deformation at the close of Triassic time portions of the sea bottom on which Upper Triassic sediments had been deposited were lifted above the water. Erosion began with the uplift of this land. Valleys were developed, and the rock material that had been uplifted was in part returned to the sea to be deposited again in younger formations. This period of erosion may have continued throughout early Jurassic time, for no Lower Jurassic rocks have yet been certainly recognized on the peninsula.

With the approach of mid-Jurassic time considerable areas in the northeastern portion of the peninsula were submerged, and over these submerged areas gravels, sands, and clays were deposited to a depth varying from 1,500 to 2,500 feet. The full extent of the Middle Jurassic sea in this part of Alaska is not yet known, but the work of Stanton and Martin has shown that the waters covered a large part of the present land area on the east side of the peninsula in the vicinity of Cold Bay. The shales, sandstones, and conglomerates resulting from the consolidation of the sediments washed into the Middle Jurassic sea could have come only from land relatively near. The absence of limestone suggests that the waters were not free from land-derived sediments over any considerable areas, or for any considerable length of time during this period.

The close of mid-Jurassic time was not, so far as is now known, marked by any great physical revolution. The relationship between the Middle and Upper Jurassic rocks appears to be that of conformity,

which would indicate that sedimentation continued from mid-Jurassic time on into late Jurassic time without interruption. More extensive studies may show, however, that this continued sedimentation did not prevail throughout the peninsula.

The Naknek formation, which represents late Jurassic time on the peninsula, is, according to present information, more widespread than any older formation. The accumulation of at least 1,000 feet of sandstones, conglomerates, and arkoses during late Jurassic time, and the distribution of these sediments from the northeastern portion of the peninsula as far to the southwest as Herendeen Bay, indicate that the sea was shallow over a considerable part of the area now known as the peninsula, and that the sources from which such sediments were derived were not far distant from the present outcrops of the Naknek formation.

The structural relations between the Upper Jurassic and the Lower Cretaceous rocks are not known, and it is therefore impossible to state exactly the conditions at the close of late Jurassic time or the opening of early Cretaceous time in this portion of Alaska, or to define clearly the line of demarcation between the two.

LATE MESOZOIC TIME.

Lower Cretaceous rocks have been recognized in only one small area in the peninsula, just east of Herendeen Bay. If beds of that age are absent elsewhere in the peninsula it may be either that the rest of the peninsula existed as a land area or that the Lower Cretaceous rocks have been uplifted above the sea and carried away by erosion. In the area mentioned they include at least 1,800 feet of rocks, 800 feet of which are arenaceous limestone and the rest chiefly shales, with some sandstone. The shales and sandstones indicate that there was land near by, but the limestone overlying the shales show that the waters were clearing, possibly because of a slight lowering of the neighboring land, or even a depression of land below sea level, or a reduction of the land to a level so low that little detrital material was carried from it into the neighboring sea.

At the close of early Cretaceous time there was probably sufficient movement to interrupt sedimentation, for the available data indicate an unconformable relationship between the Lower and Upper Cretaceous rocks. This disturbance may have resulted in widespread erosion over most of the peninsula lands. The sea again encroached upon the peninsula at the beginning of late Cretaceous time and covered areas in the vicinity of Herendeen Bay, Port Moller, Chignik Bay, and far to the northeast near Douglas village. Whether the sea was then continuous between these points is not known, but it is possible that most of the present lands of the peninsula were submerged during this time. The conglomerates, sandstones, shales, and

coal indicate, however, that land was near at hand. The coal beds show that there were large swamps or marshes near sea level containing luxuriant vegetation. The swamps were submerged by slight oscillations of the land relative to sea level, and sands, clays, and gravels were deposited over the accumulated vegetable matter. Later similar marshes came into existence through a slight upward movement that brought the sea bottom just to or above the water level, and in these marshes additional vegetable matter was accumulated. In time, by another slight oscillation, this later vegetable material was buried by sediments derived from some near-by land. Such conditions continued throughout the period of deposition of the material that formed the coal measures. No decided physical change took place in this part of Alaska at the close of Upper Cretaceous time.

TERTIARY TIME.

The similarity of the Eocene sediments to those of late Cretaceous age and their conformable relationship indicate a continuation of the same physical conditions from the beginning of late Cretaceous time to the close of Eocene time. The early Tertiary sediments are at least 5,000 feet thick in parts of the peninsula, and consist of shales, sandstones, grits, conglomerates, and some lignite. The sandstones, shales, grits, and conglomerates are not unlike those formed in the preceding period, and like them indicate that land areas were near at hand. The beds of lignite indicate that conditions favoring dense growths of vegetable matter alternated with conditions favoring accumulation of sandstones and shales. The peninsula was subject to slight changes of position and stood by turns a little above sea level and a little below the water surface. Such minor oscillatory movements commonly precede great periods of deformation, and the close of the Eocene epoch was marked by orographic movements and volcanic activities so distinct as to prove that the Alaska Peninsula was no exception to the rule.

The distribution of Eocene sediments indicates that the oscillatory conditions above described existed very generally over the southwestern part of the peninsula and at places, at least, along the eastern coast farther north. To what extent the Eocene sediments have been removed from places where they once existed can not now be told.

These early Tertiary sediments have not yet been found in a horizontal position at any place on the peninsula or neighboring islands, but have been upturned in each of the areas. In the Chignik Bay region they are gently folded, and farther west, even to Pavlof Bay, they form the great anticlinal arch in the core of the peninsula.

Miocene sediments have not been found upon the Eocene except at one locality in the northwestern portion of Unga Island, where they

rest conformably upon the Eocene. This conformity would indicate that Unga Island was not involved in the general orographic movement that marked the close of Eocene time on the peninsula. The movement that affected the sediments on Unga Island occurred a little later.

The orographic movements that marked the close of Eocene time brought certain portions of the peninsula above water, in this way modifying the shore line and determining new areas favorable for sedimentation. It appears that many small bays or inlets where such sediments could be deposited existed at the beginning of Miocene time. These bays do not appear to have been formed entirely by the original structural features, and may therefore have been formed in part by erosion following the period of deformation at the close of the Eocene and in part by a slight depression of the land which allowed the sea to enter the lower portion of the larger valleys. Miocene sedimentation was in progress along the coast line, as is shown by the small areas of Miocene rocks on the borders of the peninsula and neighboring islands. It is fair to assume that the small areas now existing are mere remnants of Miocene sediments formerly much more extensive.

Volcanic activities were distinct in this portion of Alaska near the close of Eocene time, or at the beginning of Miocene time. In the upper Eocene there are great laccolithic intrusions and numerous dikes and sills. In addition to these igneous rocks, extensive flows of andesite, some flow breccia, and local accumulations of volcanic tuffs appear to have followed the deposition of upper Eocene sediments. It is not certain that this period of volcanism ceased during the period when Miocene sediments were being deposited, but it is certain that at the close of Miocene time, or later, great masses of igneous rocks were intruded into the sedimentary series.

The close of Miocene time was marked by a lesser deformation than that which occurred at the close of Eocene time, but this later movement was sufficient to upturn and to fold gently the Miocene sediments at most of the places where they have been discovered. The periods of volcanism which marked the close of both the Eocene and the Miocene times were associated with periods of deformation. When periods of volcanism and deformation coincide lavas approach the surface more readily than at other times and gain access to the surface through the weakened or broken crust of the earth.

The deformation which marked the close of the Miocene epoch modified the coast line of the peninsula and probably raised a greater land area than the present peninsula above sea level. This conclusion is based upon the absence of Pliocene sediments, so far as now known, from the peninsula, which leads to the inference that at least the present area of the peninsula was above water, and upon the

drowned coast line indicated by the numerous and in many places fiordlike bays, which shows that there has been a recent depression of the peninsula and therefore an advance of marine waters over portions of what had just previously been land. This depression may have taken place just before, during, or after Pleistocene time, but it undoubtedly came after post-Miocene erosion had begun, and the absence of Pliocene sediments suggests that it was later than the Pliocene epoch.

QUATERNARY TIME.

Glaciation.—During the Pleistocene epoch there were extensive valley glaciers throughout this portion of Alaska, at least as far to the southwest as Pavlof Bay. The ice formed among the summits of the Aleutian Range at the heads of well developed valleys, and in the movement of the resulting glaciers toward the Pacific Ocean or toward Bristol Bay the valleys were greatly deepened and broadened. The glaciers made the basin areas high among the mountains much broader, and in many areas left deposits of glacial drift.

The islands—most notably Unga Island—have been greatly modified by ice action, so far as they have been examined. Valleys have been broadened and deepened, foothills reduced in elevation, and lowlands mantled with morainic deposits. The glacial geology of the region is fully discussed on pages 84 to 91.

Recent geologic history.—Since the retreat of the ice the agents of weathering have renewed the work of disintegration on all uncovered surfaces. Streams have carried the fragmental material resulting from the processes of this disintegration to lower levels, spreading some of it over the bottom lands in the valleys and depositing some at the heads of bays and along the outer coasts. The waves, undertow, and shore currents have cooperated to modify the coast lines. Erosion has been in progress at some places but at other points deposition has predominated. The modern shore-line features, which will be described more fully later, have been developed as a result of these various processes. Since the retreat of the ice the sea has withdrawn from some of the lower lands bordering the coast, so that the former shore line is about 100 feet above the present mean-tide level. Locally volcanic activity has continued.

GEOMORPHOLOGY.

MEANS OF INTERPRETATION.

In working out the physical history of a province no sharp line can be drawn between geologic and physiographic studies even for any one region, much less for different regions or for different portions of any large province. The physiographic history of a region comprises

only the later chapters of the geologic history; but field observations and field methods of work in physiographic studies may differ somewhat from the observations made and the methods used in working out the earlier geologic history. In physiographic studies special attention is given to the present forms of the land, to the topography, to the relation of topographic forms to geologic structure, and to the different kinds of rocks, and to the broad topographic relations of different land forms. Physiographic study also involves a careful examination of all recent deposits. The unconsolidated sediments may contain in their materials, their forms, and their topographic relations the record of the most recent happenings in that region. When the evolution of the present land forms has been fully worked out the later geologic history of the region has been determined.

EOCENE SEDIMENTATION AND THE GROWTH OF THE ALEUTIAN RANGE.

The present distribution of the Kenai formation makes it evident that Eocene sedimentation was widespread in the Alaska Peninsula, and it is undoubtedly true that this formation was formerly more widespread and more continuous than it is to-day. The nature of the sediments and the life record in these rocks show that the deposits were made alternately from shallow marine water and from marshes during the early and middle portions of the period. Local volcanoes existed in early Eocene time and toward the close of the period, and numerous centers of active volcanic action were associated with a general orographic movement. Great masses of lava were thrust into, and in some places through, the Eocene sediments, and vast quantities of fragmental materials were scattered over portions of the area.

The volcanic activities of this period were attended by a general deformation of the strata and by the uplift of the Aleutian Range of mountains. Earlier mountain ranges may have existed in this portion of Alaska. Mountains may have been formed during Mesozoic times in the northeast portion of the peninsula, but if these earlier mountains were thus formed, they were probably largely removed by the close of Eocene time. The first and probably the greatest period of growth of the modern Aleutian Mountains came near the close of Eocene or at the beginning of Miocene time. The general outline and major physiographic features of the Alaska Peninsula were then much the same as they are to-day.

MIOCENE EROSION AND POSSIBLE PLANATION.

The rocks that formed the land surface that was uplifted at the time indicated may not anywhere exist to-day. So far as the region has been examined no portion of that surface has been recognized;

on the contrary, there is abundant evidence that vast quantities of rock, in some places thousands of feet thick, have been removed. Disintegration began when the land rose above the sea and the winds and streams undertook their work of carrying the loosened material to the sea. Ocean waves attacked the margin of the new land, cutting away the softer and more exposed portions, while the undertow and shore currents shifted the loosened material to favorable sites for deposition. The sediments deposited during this period contain the records of Miocene marine life. These sediments, so far as is known. are limited to small baylike areas at the margins of the peninsula or near the shore of the neighboring islands; indeed, they have been found only in the western part of the peninsula, in the vicinity of Balboa and Herendeen bays and on the islands of the Shumagin group. It appears, therefore, that the northeastern part of the peninsula was somewhat larger during Miocene time than now, and that a large part of the sediments of Miocene age now lie on the sea bottom, perhaps some distance beyond the present margin of the land.

How far this process of erosion succeeded in reducing the land during Miocene time is as yet uncertain. No doubt the land stood much lower, relative to the sea, than it does to-day, for Miocene sediments of marine origin have been found fully 1,000 feet above sea level in nearly horizontal positions. At these localities the summits in the central portion of the range are from 2,000 to 3,000 feet above sea level. There is a striking correspondence of summit levels over large areas of the Aleutian Range (Pl. XI, *B*) and it is quite possible that these summits are portions of a deformed peneplain of late Miocene age.

DEFORMATION AT THE CLOSE OF THE MIOCENE.

At the close of the Miocene there was an orographic movement which brought portions of the sea bottom out of the water and tilted or gently folded the Miocene and all older sediments. The movement at this time was not so great as that at the close of the Eocene. Miocene sediments were elevated at least 1,000 feet, and the main arch of the Aleutian Range was uplifted. Marginal cross folding probably defined at this time the location of the chief or larger indentations of the coast and the distribution of some of the smaller islands neighboring the peninsula.

PLIOCENE EROSION.

With the uplift of the lands the streams began working to a new base level. Where new lands rose at the margins of the peninsula the streams were forced to extend their courses to the new coast line. This period of erosion has continued, except for local interruptions due to volcanism, glaciation, or slight changes in the elevation of

the land, to the present time. The sculpturing of the main mountain range, begun at the close of the Eocene time and brought possibly to a peneplain stage by the close of Miocene, was renewed. Great valleys were located and were deepened, broadened, and lengthened as time went on. The mountain masses became more sharply defined, and the intervening ridges were left narrower. When the land rose at the close of Miocene time the waves and shore currents began work at a new horizon. Wearing was in progress at some places and building at other points. The main physiographic features were roughly outlined at this time, but their forms have been greatly modified by glaciation and later erosional and deposition work.

GLACIATION.

GENERAL EFFECTS.

The Pleistocene glaciation, which is only one chapter in the long history of degradation and aggradation that dates back to the close of Miocene time, has produced the present general form and the details of many of the more important physiographic features in this part of Alaska. In those parts of the peninsula that have been studied in detail there is evidence of glaciation from the crest of the range to the shore lines, both to the northwest and southeast. The glaciers formed among the summits of the Aleutian Range and were guided in their movements by the preglacial erosion lines, the ice forming near the crest of the range advancing down the valleys. The glaciers reached the sea on the Pacific Ocean side and must have yielded vast numbers of icebergs. To the northwest the ice deployed on the lowlands at the base of the mountains and there formed great piedmont glaciers that advanced nearly or quite to the margin of Bering Sea.

Among the summits of the range the work of the ice is recorded in the great amphitheatrical cirques and in the sharpened peaks and divides. The valleys have been changed from the V-shaped depressions characteristic of youthful stream-made canyons to broad open U-shaped troughs. In the northeastern portion of the peninsula the four large lakes—Kukaklek, Naknek, Becharof, and Ugashik—probably owe their present depth and outline, if not their existence, to ice gouging. With the exception of Ugashik Lake, they lie in valley courses leading from the mountain peaks to the shore of Bristol Bay. The longer dimension of Ugashik Lake is approximately parallel to the axis of the peninsula, and it is unlikely that glaciers moved in that direction; but the ice in passing across the basin must have deepened and broadened the area now occupied by the lake. The narrow tongues of ice which filled the well-defined valleys to the sea so excavated those depressions that upon the retreat of the ice the sea invaded the land areas (Pl. VIII, p. 42) in long, narrow bays or fiords.

Bare rock surfaces on the canyon walls have been polished and striated, and rock surfaces bordering the bays in the lowland areas show the usual marks of glacial wear, such as striæ, grooves, and polishing.

Much of the material gathered by the ice was deposited offshore or carried out to sea by icebergs; but a portion of the material was deposited on the present lands of the peninsula. The glacial drift is most extensive on the lowlands of the northwest side of the peninsula. There the deposits, so far as they have been examined, mantle the lowland area and give to it a topography similar to that of the glaciated portions of the upper Mississippi Valley. The moraines have the characteristic hummocky form, with small knobs and shallow depressions. Water has accumulated in many of the depressions, so that this portion of the peninsula has numerous small lakes and many swamps or marshes which record the former existence of lakes or ponds. In the mountain valleys the ice succeeded in removing most of the loose material and in carrying it to the sea; but on the retreat of the glaciers small areas of drift were left, as lateral moraines, medial moraines, or in a thin scattering of bowlders. The glacial geology of those portions of the peninsula that have been studied in detail will be given below.

GLACIATION OF UNGA ISLAND.

The island of Unga was almost completely covered by glacial ice during the Pleistocene epoch. This ice formed in the catchment areas among the higher peaks of the central portion of the island and moved seaward, guided in its direction during the earlier stages of its movement by the main drainage lines of the island. As the snows became thicker and the quantity of ice proportionately larger, it appears from the distribution of glacial deposits and markings that the ice covered all but the higher peaks and moved in a somewhat radial way from the central portion of the island.

The glacial drift consists of intermingled bowlders and fine materials that have been deposited without having been assorted. The distribution of these deposits is indicated on Plate VIII (p. 42). Very little glacial débris occurs in the higher portions of the island, for the ice as it moved out from the central portion of the island swept along with it all the available loose material and did some wearing and smoothing of the rock surfaces. In the main valley west of Unga Harbor where the Apollo and Sitka mines are located there are considerable quantities of glacial drift, part of which is left on the valley walls as lateral moraines and part of which is deposited on the valley bottom as ground moraines. At the head of Coal Harbor are other patches of glacial drift of sufficient extent to be shown on the map. In the west central portion of the island there is a considerable quantity of glacial drift of characteristic rolling topography in

which are several undrained depressions containing water. A ridge capped throughout the greater portion of its length with glacial drift extends about 5 miles in a general westerly direction in this portion of the island. The location and form of this deposit indicate that the ice which formed it moved in a general westerly direction from the center of the mountain district and that the surface of the ice must have been only a few hundred feet below the summits of the highest peaks in the island. Numerous minor deposits of glacial drift, of too slight extent to be mapped but of sufficient extent to block drainage and to form numerous small lakes and ponds, occur in the southwest part of the island. The northwest and northeast peninsulas of the island are lowlands, over which is distributed a mantle of glacial drift in places at least 40 feet thick. This drift deposit has the characteristic rolling topography of moraine on lowland areas and is dotted among the hills or mounds with numerous depressions which serve as the beds of small lakes. These depressions are much more numerous than the topographic map indicates. The location and distribution of these deposits, which extend nearly or quite to the modern seashore across lowland areas, show that during the stage of maximum glaciation there was a small ice cap on this island.

The erosional work of the ice has modified the summit region by broadening and deepening the great catchment areas or cirques, the larger valleys, and, presumably, the inlets or bays which now indent the coast of the island. The bays have probably been lengthened as well. Thus the harbor at Unga (Pl. XI, *A*, p. 86) owes its origin, in part at least, to the gouging by the ice which moved along its course and presumably ended as the "live glaciers" of southeastern Alaska end to-day. Baralof, or Squaw Harbor, the inlet next north from the village of Unga, was also deepened, widened, and lengthened by ice action. The great U-shaped troughs at the head of this inlet contained ice more than 1,000 feet thick. The streams of ice from these troughs united near the head of the present harbor, moved eastward through the harbor trough, and must have ended as a live glacier near the present harbor entrance. Coal Harbor probably contained a very considerable glacier. The great troughs at the head of this inlet contained glaciers at least 1,000 feet thick that probably advanced nearly as far north as the island extends. The small island in the midst of Coal Harbor is so rounded as to suggest that the ice passed over and about it during the glacial period.

The evidence of the erosional work of the ice includes all those features common to mountainous regions that have been glaciated and, also, in the modifications of the coast, the deepening of fiord-like inlets such as characterize most glaciated rocky coasts.

A. UNGA HARBOR FROM THE WEST.

See page 86.

B. ANCHORAGE BAY FROM THE SOUTHWEST.

Beyond the larger body of water, which is a portion of Chignik Bay, are the Aleutian Mountains. The correspondence of summit levels is somewhat remarkable. See pages 75, 83, 90, 108.

The glacial drift of Unga Island varies greatly in its composition from place to place. Examination of the geologic map (Pl. VIII, p. 42) will explain the differences in the constitution of the drift, for the variety of igneous and sedimentary rocks that outcrop in the island readily accounts for the variety of stones found in the drift. Most of the stones in the material of the glacial deposits are less than a foot in diameter. The fine material consists of coarse sands and gravels derived from disintegration of crystalline rocks or from wearing of sedimentary formations, and of clay originating in the most thoroughly decomposed portions of the igneous rocks, or in the partially consolidated Tertiary beds. The actual amount of glacial drift in the mountainous portion of the island is very small, a condition consistent with these in many other mountainous areas that have been glaciated. The ice cap of Unga and the distinct valley glaciers that characterized the early and late stages of glaciation in the island must have carried vast quantities of débris to the sea.

The present valleys are the upper portions of the former glacier courses, and in these upper courses deposition is not usually conspicuous. Alpine glaciers commonly scour out the heads of the valleys and carry the loose material gathered in the process to the maximum position of the ice advance. Here the glacial material was carried to the sea and distributed by the waves, currents, and icebergs over the sea bottom.

No evidence of distinct glacial epochs was seen in this island or, indeed, in any of the places studied in southwestern Alaska. The ice presumably left the higher mountainous area much later than it left certain of the lower or southern mountain ranges in the Western States or the areas occupied by the continental ice sheet.

GLACIATION OF POPOF ISLAND.

Popof Island is just east of Unga Island. A sufficient mantle of glacial drift remains in the northwestern corner, the part visited by the writer, to indicate that ice probably covered the greater part of the island during the Pleistocene epoch. Small lakes and ponds are not uncommon in the island, and the depressions in which they lie are probably due to the irregular distribution of morainic material.

GLACIATION OF THE BALBOA-HERENDEEN BAY DISTRICT.

Much of this portion of the Alaska Peninsula was covered by ice during the Pleistocene epoch and the glaciers presumably did not leave the higher mountain areas until long after the ice had left the interior of the continent. Evidences of glaciation in this region appear in the great cirques or catchment areas, the broad, open, U-shaped canyons, the fiords, or bay-like inlets, the smooth, striated,

and polished surfaces of bed rock, and the characteristic glacial deposits, which are somewhat widely though irregularly distributed in the region.

The ice formed among the summits of the Aleutian Mountains and in its movements was directed by the drainage lines which existed in preglacial time. Those drainage lines were deepened and broadened; the present U-shaped form of the valleys is interpreted as of glacial origin, and the amphitheatral catchment basins at the heads of the canyons owe their present form chiefly to ice action. The higher summits may have risen as nunataks above the ice during the maximum extent of glaciation. The passes and all the great valleys were occupied by the glaciers, and the lowland areas, wherever they have been examined, were formerly overridden by ice. This region, during the glacial period, was, presumably, a great arch of snow and ice, extending to tidal waters on either side of the peninsula. Above the snows of the catchment area a few dark specks may have appeared where the higher peaks protruded above the white mantle. The glaciation was not of a mild form. The catchment areas show signs of intense ice action, and the broad, open, U-shaped troughs are evidence of vigorous erosion by the ice. The indented coast line of this portion of the peninsula is accounted for in part, at least, by the intense glaciation which has affected the region. It is fair to assume that the bays and various inlets were depressions, presumably drainage lines, in preglacial time, but their present extent and outlines were notably changed by the glaciers. The markings on the polished and striated rock surfaces that occur at various places within this area indicate the direction of ice movement at each place. The striæ are in general parallel to the stream courses and indicate that the movement of the ice was controlled by the preglacial topography. Striated surfaces a few feet above sea level on the shores of Balboa Bay make it evident that the ice occupied at least the head of that inlet and that the action near the coast was vigorous.

The glacial deposits consist of irregular patches of morainic material lodged on the valley slopes as lateral moraines or at the junctions of valleys as medial moraines. Some of the patches mapped cover the lowlands or floors of the valleys and should perhaps be classed as ground moraines. The valley walls are commonly too steep to have allowed the lodgment of any considerable quantities of drift on them, and the only areas in this district where drift deposits are extensive are near the head of Port Moller, in the vicinity of Point Divide, and on the islands still farther northwest. (See Pl. VIII, p. 42.)

The drift deposits about 1 mile west from the head of Balboa Bay are distributed as lateral and medial moraines. These deposits appear as ridges 20 to 50 feet high on the lower slopes of the valley, and as slightly larger forms where two lateral moraines have joined

to form a medial moraine. The surfaces of the morainic ridges are strewn with bowlders, and the exposed sections exhibit the structureless nature of the deposit. Most of the stones are subangular and many of them are striated.

The glacial drift near Point Divide and at the head of Port Moller forms a mantle on the lowlands and gives to the surface a gently rolling topography characteristic of ground moraines. Exposures in the drift may be seen along the shores of the bay and in some of the stream cuttings, and in these exposures the material has the characteristic physical and lithologic heterogeneity of glacial deposits. The surface of the moraine is clothed with a thick tundra growth which obscures the rock material and softens the contour of the drift hills.

The most extensive glacial drift deposits in the Balboa-Herendeen Bay region cover the lowland area extending from the base of the mountains northwest to the modern beach deposits of the Bering Sea shore. Exposures along the beach near Point Divide show that this drift mantle is at least 40 feet thick in places. The material in this part of the Alaska Peninsula resembles the glacial débris already described, and its topography is not unlike that of other lowland areas that have been covered by drift. The surface of the moraine is characterized by undrained depressions and low hills, which gives the land a gently rolling topography. In many of the undrained depressions there are ponds or small lakes.

The nearer of the low islands beyond the mainland of the peninsula are known to be mantled with glacial drift. These islands rise 30 or 40 feet above the water. The outer islands, which were seen only from a distance, may be composed in part of glacial material, but as the lands have risen at least 100 feet since the retreat of the glaciers the outer islands are probably mantled with recent shore line alluvium. White residents of this coast report extensive sand dune areas along the outer beach.

The glacial deposits near the head of Herendeen Bay are lodged in places unfavorable for removal by erosion. They cover small areas in the lower portions of glaciated valleys and appear in form and in topographic relations to be only remnants of lateral or medial moraines.

The drift in this region consists of unstratified bowlder clays. The stones differ greatly in different places, and include a wide range of sedimentary formations, together with a considerable amount of igneous material. The sizes of the stones range up to at least 6 feet in diameter. The variety of this material is readily accounted for by the distribution of the many varieties of rock formations within the area.

No evidence of distinct glacial epochs is found in this region. The ice of the most recent epoch, if, indeed, earlier glaciers ever occupied these valleys, apparently moved down the main valleys beyond the present shore lines and obliterated the record of the former occupancy.

GLACIATION OF THE CHIGNIK BAY REGION.

In the Chignik Bay region of the Alaska Peninsula, the central and higher peaks reach elevations between 2,000 and 3,000 feet. The snows lodged and ice formed in the large catchment areas among the summits during the glacial period, and from these basins the ice moved in a general way southeast toward the Pacific Ocean, and northwest toward Bering Sea. Movement of the glaciers while the ice accumulated and during the earlier stages of glaciation was controlled by the location of the main drainage lines of the region. Later the ice became more extensive and overrode many of the inter-valley areas. The northwest base of the mountains was not seen in this district, but records left by piedmont glaciers may be anticipated for that region.

The cleaned-out condition in the basin region indicates very vigorous ice action, and the scarcity of loose material of postglacial origin may mean that the ice has but recently left these mountains. The large valleys leading away from the catchment areas are broad, open, U-shaped troughs. The chain of lakes crossing the peninsula from the head of Chignik Lagoon appears to owe its origin partly to ice gouging and partly to the deposition of glacial débris. The head of Chignik Bay and the whole of Chignik Lagoon, Anchorage Bay (Pl. XI, *B*, p. 86), Mud Bay, and the various inlets south of Castle Cape were undoubtedly deepened and broadened by ice action. Hook Bay, farther north, was in part formed by the action of glacier ice.

Deposition by the glaciers was chiefly on the lowlands bordering the Pacific and Bering Sea sides. Descriptions given by travelers to the writer indicate that the lowlands northwest of the mountain range must be mantled by glacial drift. The lowlands in the immediate vicinity of Chignik Bay contain irregular patches of glacial drift, as do also the hillsides, where the slope is not too steep to prevent the lodgment of drift.

Glacial drift has been indicated on the geologic map (Pl. VII, p. 40) where such material mantles and obscures the underlying formations. Two small areas of morainic deposits shown on the map near the lower end of Chignik Lake lie in the course of a former glacier that must have moved eastward from the mountains west of Chignik Lake through the lake basin, down the Chignik River valley into Chignik Lagoon, and possibly into Chignik Bay. Scattered

remnants of the morainic deposits of this glacier were seen at several points, but in only a few areas were the deposits of sufficient extent to be properly represented unless a larger scale map was prepared. Along the shores of Chignik Lagoon there are, at a few points, good exposures in morainic deposits. Large and small bowlders are intermingled with clays, sands, and gravels. The material is unstratified, and appears to be just as it was deposited by the melting of the ice. Many of the larger stones are subangular in form and their surfaces are not uncommonly striated. The larger area of moraine covered country south of Chignik Lagoon and near the low pass to the head of Kuiukta Bay has a glacial topography modified but slightly by post glacial stream erosion. The scattered patches of glacial drift near the northwest shore of Chignik Bay are regarded as mere remnants of moraines that probably mantled much of this piedmont area.

As yet no indications of distinct glacial epochs in the Chignik Bay region have been seen. The ice of the Recent glacial epoch appears to have advanced on the Pacific Ocean side to tide waters, and such ice would in all probability have removed all evidence of any previous glacial epoch.

RETREAT OF THE ICE.

When the climate became warmer, less snow was precipitated and the glaciers began to retreat. There was no backward movement, but the melting was in excess of the onward movement, and accordingly the margin of the ice came to be farther and farther from the shore. The last remnants of the glaciers were therefore in the basins where the first ice formed. The glaciers still remaining in the northeastern portion of the peninsula are the shrunken remnants of the ice that occupied the great valleys in that region during the Pleistocene epoch.

As the ice retreated streams issued from beneath the ice and distributed down the valleys from the margins of the glaciers vast quantities of sands, gravels, and clays, and partly refilled the troughs that the glaciers had deepened. At this time the lands stood at least 100 feet lower than they do to-day, and much of the material deposited by the ice or washed from beneath the glaciers by streams was deposited in water. As the ice tongues became shorter the fiords became longer, and when at last the ice had left the lower portions of the valleys and retreated to the catchment basins waterways reached well into the central portion of the peninsula. In the Chignik Bay region there must have been a continuous water route from the Pacific Ocean to Bering Sea.

POST-PLEISTOCENE EROSION.

Since the close of Pleistocene time the lands have been subject to the work of streams and to all those processes tending toward the disintegration of rocks and to their removal to the sea. Winds, rains, changes in temperature, and frost action have been loosening and comminuting all rocks exposed to the atmosphere. Water beneath the surface has assisted in weakening the rocks by taking up their soluble salts, and has thus indirectly hastened their journey to the sea. Erosional wind work is not very noticeable, but depositional work by the winds has built up numerous small dunes at various places on Unga Island and on the mainland to the north. Dune forms will undoubtedly be found at various places along the Bristol Bay side of the peninsula.

Some talus has accumulated among the higher peaks in the general degradation of the lands, and where conditions were favorable landslides have taken place. Several considerable areas owe their topography to landslide blocks or masses that have moved from some bordering cliff.

The glaciers at the northeast are active agents of erosion, for they are undoubtedly lowering the valley bottoms over which they move, broadening and deepening the basins near the summits, and grinding much of the material carried near the base of the ice into finer and finer particles. This northeastern part of the peninsula is now undergoing a glacial period.

Streams have renewed their work of wearing and of carrying loose material to the sea. Some rivers are still engaged in removing the glacial débris left in their courses; other rivers, that have had little morainic material to handle, have cut narrow gorges in the rock at the bottoms of the canyons. At the heads of all of the larger bays the waste brought down by the streams has helped to extend the lands. Deltas have been built out into the bays, and are still in the process of growth.

MODERN SHORE LINES.

The Pacific Ocean side of the Alaska Peninsula presents a bold, rugged coast, bordered at many points by steep cliffs, and indented by fiordlike inlets separated from each other by headlands of most rugged and fantastic features. The smaller islands bordering the coast appear in places to be continuations of the headlands, separated from them by wave erosion. The larger islands, notably the Shumagin group and the Sannak Islands, are chiefly of volcanic origin and appear to have been throughout their history distinct from the mainland of the peninsula. The shore line features include sea cliffs, overhanging ledges, arch rocks, sea caves, rock pillars, balanced rocks (Pls. V, p. 38; IX, *B*, p. 62; and XII) and, at the heads of

A. SEA CAVES AND AN ARCH ROCK ALONG EAST COAST OF UNGA ISLAND.

See page 92.

B. SHORE LINE PILLAR OF CONGLOMERATE.

This has been separated from a neighboring cliff by wave erosion. See page 92.

many bays and inlets, sand bars, hooks, spits, barrier beaches, land-tied islands (Pls. IV, *B*, p. 12; XIII, *A*, p. 108; figs. 11; 12; 16, p. 107; and 18, p. 129) or bayhead deltas. The activities along the Pacific coast appear to be chiefly those of erosion, and amount of shore line deposition is almost insignificant.

The larger features of the coast, the bold headlands, the bays, and the fiords, are explained in part by glacial gouging and in part by recent sinking of the land. The sea cliffs, overhanging ledges, arch rocks, sea caves, and rock pillars are due to the erosional work of the waves, which are active along a zone that extends a little below sea level and a little above sea level. Rock material is loosened and broken along that horizontal zone, and the resulting fragmental material is carried away by the undertow and currents. Undermining results and sea caves with overhanging ledges of rock come into existence. In narrow projecting points sea caves may so develop that arch rocks are left. In time increased undercutting causes the overhanging rock to fall, and the sea cliff retreats. When such work is progressing rapidly, the shore line features are rugged and signs of active change are abundant. The sea terraces referred to on the mainland coast and near the margin of Unga Island (Pl. X, *A*, p. 70) record wave work when the sea stood higher relative to the land areas. Such terraces may not have been developed all along the coast, or they may have been destroyed by subsequent wave action at many places where they formerly existed.

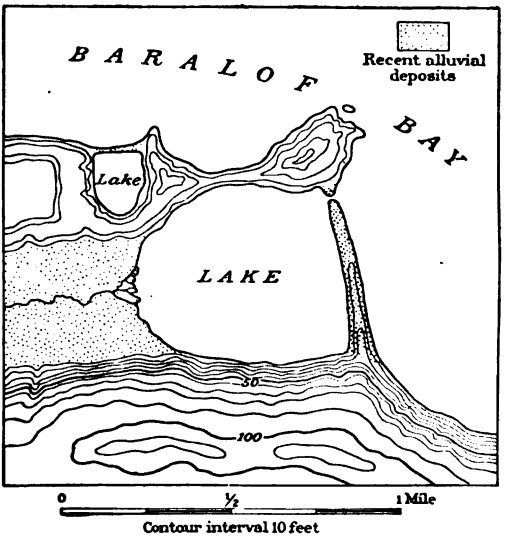


FIGURE 11.—Sketch map of shore features near south entrance to Baralof Harbor, Unga Island.

The lands are low and the waters shallow along the Bristol Bay margin of the peninsula. The waves strike the bottom long before they reach the coast, and instead of doing much erosional work they are chiefly active in the deposition of beach materials. Low sea cliffs are reported near the head of Bristol Bay, but southwest of that point sand and gravel beaches, sand reefs, small islands, and offshore bars characterize the coast. The waves, undertow, and shore line currents are engaged in shifting the loose materials

from place to place. The few large bays on this side are due in part to sinking and in part to ice gouging, as were the main inlets on the Pacific Ocean side.

RECENT CHANGES IN LEVEL.

The configuration of the coast line of the peninsula indicates that in relatively recent geologic time this land area has been somewhat depressed. The great bays and fiords do not appear to be due entirely to glacial erosion, nor can all the islands that continue seaward from the headlands be explained by glacial erosion or shore-line activities. A slight depression of the land would account most simply for these features. The sea terraces that now lie 100 feet above the mean tide level, and the alluvial flats that extend upstream to an elevation of about 100 feet in the larger valleys indicate that the lands recently stood somewhat lower and have since been uplifted. The amount of uplift has not been equal to the amount of depression, and as a consequence the coasts still retain features due to partial drowning. Whether this depression came a little before, contemporaneous with, or a little after, glaciation can not be positively asserted.

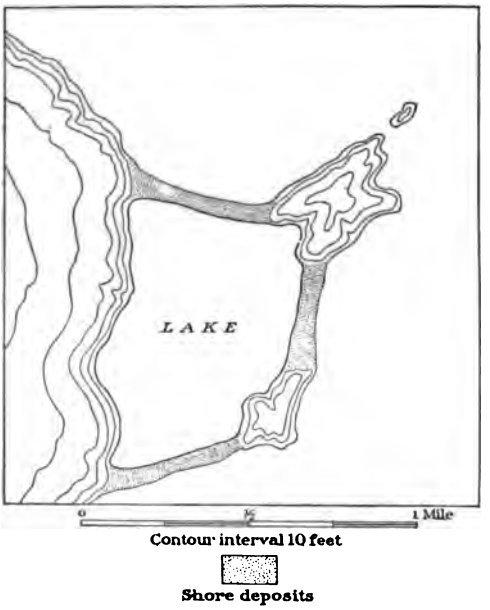


FIGURE 12.—Sketch map of shore features near north entrance to Baralof Harbor, Unga Island.

The sea terraces, however, contain some worked-over glacial drift upon their surfaces that may have been deposited offshore during the period of maximum glaciation or later. The alluvial deposits which extend far into the peninsula (Pls. VI, in pocket; VII, p. 40; and VIII, p. 42) suggest the former existence of long bays, many of which were bordered by high mountains and must have been like the present fiords of Norway and Sweden. Since the retreat of the ice and the more recent uplift of the land which brought the sea terraces and the upper portions of the fiords above water, erosion by streams, waves, and shore-line currents has been renewed at a new horizon. The streams have taken up the work, left by the glaciers, of carrying the materials of the land to the sea;

the waves are actually engaged in modifying the coast; the winds are assisting in redistributing loose material; and the agents of weathering are doing their part in the general disintegration of exposed rocks.

SUMMARY OF LATE GEOLOGIC HISTORY.

Toward the close of Eocene time an orographic movement disturbed Alaska Peninsula and defined the present chain of the Aleutian Range. Erosion began with the growth of the mountain, and continued through Miocene time. While erosion was in progress on the land, Miocene sediments were being deposited about the shores, so that during the period of erosion, the mountain area was reduced to a land of much less relief than the present, and perhaps to a peneplain. At the close of Miocene time a renewal of mountain growth brought about a rejuvenation of the streams and opened a new cycle of erosion, which continued during the Pliocene epoch. By the opening of the Pleistocene epoch the valleys thus eroded probably reached nearly to the crest line of the range. Ice formed among the summits and advanced on either side of the peninsula to sea level. The land probably stood higher during the Pliocene epoch than it does at present, but during Pleistocene time it appears to have been somewhat lower than it is to-day. A slight upward movement of the land and a renewal of stream erosion followed the retreat of the ice and the disappearance of glaciers from the greater part of the peninsula. The coast which now presents so many remarkably interesting features has been profoundly affected by each period of mountain growth, by glaciation, and by recent changes in the level of the land relative to sea level.

MINERAL RESOURCES.

DISTRIBUTION OF KNOWN MINERAL RESOURCES.

The known mineral wealth of southwestern Alaska consists of coal, petroleum, gold, and copper. The general distribution of these deposits is shown on Plate VI. The important coal fields are near Chignik Bay and near Herendeen Bay. Less important deposits of coal and lignite have been found in Unga Island and at a few places in Alaska Peninsula. Near Amalik Harbor Dall [1] noted an 18-inch bed occurring in a sandstone and conglomerate series 250 feet thick. Stone [2] described a section at this same locality made up of sandstones and fine conglomerates, with some shales, in which occurs a 5-foot bed of coal, and made reference also to less well-authenticated accounts [3] of the occurrence of coal at Ugashik Lake and Aniakchak Bay.

[1] Dall, W. H., Coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, p. 702.
[2] Stone, R. W., Coal in southwestern Alaska: Bull. U. S. Geol. Survey No. 259, 1905, p. 161.
[3] Idem, pp. 162-163.

The first coal mining undertaken by Americans in this portion of Alaska was begun in 1882 at Coal Harbor. Previous to that time the Russians had taken out some coal from the same field. Work was begun on the coal at Herendeen Bay in 1880, but no shipments were made until 1890. Coal was discovered on Chignik River in 1885, and mining began at that locality in 1893.

The oil seepages occur in the vicinity of Cold Bay. Placer gold has been found in paying quantities in the beach at the west margin of Popof Island just south of Sand Point. Several locations for gold have been made on Popof Island, and lode mining was conducted successfully on Unga Island from 1891 to 1904.

On the west shore of Prospect Bay, a small reentrant a few miles west of Chignik Bay, there are evidences of copper, and on the east shore of Balboa Bay there is an abandoned copper prospect.

COAL.

HERENDEEN BAY COAL FIELD.

GEOGRAPHY.

Herendeen Bay, the western arm of Port Moller, is on the northwest side of the Alaska Peninsula at about 160° west longitude and 55° 30′ north latitude. (See Pl. VI, in pocket.) The head of the bay is near the central portion of the peninsula, and is only 8 miles from the head of Balboa Bay, a reentrant on the Pacific side. The portage from one of these bays to the other is made by an excellent trail over a pass not more than 500 feet above sea level, which connects two broad, flat-bottomed valleys.

Gently rounded hills and low mountains make up the topography of the coal field (Pl. II, p. 12). The highest points are a little over 2,400 feet in altitude, but the portions above 2,000 feet constitute but a small part of the area. The largest valley is that of Coal Creek, which is located in the central portion of the field. This valley is a broad, open, flat-bottomed trough leading northward through the coal field and westward to Herendeen Bay. The small valleys drain westward into Herendeen Bay and eastward into Port Moller. They are somewhat rugged, and travel is easier on the inter-valley ridges than through the gorges.

The mean temperature is about 46° F. in the summer season from June to October. During the winter months, from October to May, the mean monthly temperature ranges from 13° F. to 39° F. The annual precipitation during 1903, when records were kept at the Herendeen Bay mine camp, was 46.22 inches. In the summer the number of clear days ranges from 5 to 10 a month. During the 3 years from 1902 to 1904, inclusive, there were 27 days when the minimum temperature was below zero and 4 days when the maximum tem-

perature was below zero. Mine Harbor was frozen in the years from 1902 to 1906, inclusive, during the following periods: December 18, 1902, to May 6, 1903; December 29, 1903, to May 26, 1904; January 3, 1905, to May 25, 1905; January 15, 1906, to March 17, 1906.

In 1908 Herendeen Bay could be reached by way of Bering Sea by private means of transportation from Unalaska or Nushagak. The more common route is by regular steamer to Balboa Bay, and thence by trail across the peninsula to the head of Herendeen Bay.

The development work that has been done in this field was described earlier in this report (pp. 19–20).

AREAL EXTENT.

The coal which has been opened and is now being developed is found in a small peninsula between Herendeen Bay and the main or eastern arm of Port Moller. (See Pl. VIII, p. 42.) Coal is exposed at various localities within that area, and coal-bearing formations occupy at least 40 square miles. Some beds of lignite that outcrop on the western shore of Herendeen Bay are reported to extend several miles to the west. Other beds of lignite outcrop in the mountain slopes east of the trail to Balboa Bay, in the central portion of the Alaska Peninsula. The areal extent of the lignite-bearing beds is several hundred square miles, but the known extent of lignite seams that may ever prove to be of economic importance is something less than 10 square miles.

GEOLOGY.

STRATIGRAPHY.

The bituminous coal in the Herendeen Bay field occurs only in the Chignik formation. This formation is of Upper Cretaceous age. It rests upon

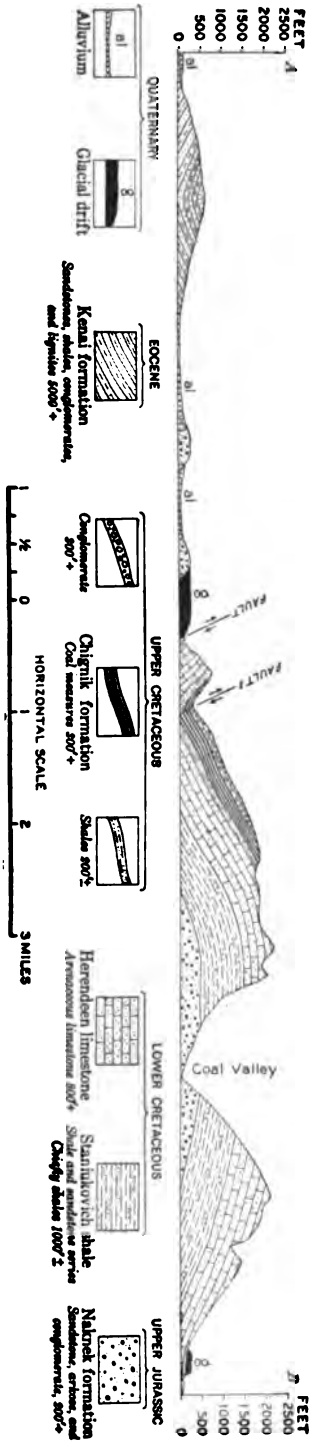


FIGURE 13.—Structure section across Herendeen Bay coal field along the line *A–B*, Plate VIII (p. 42).

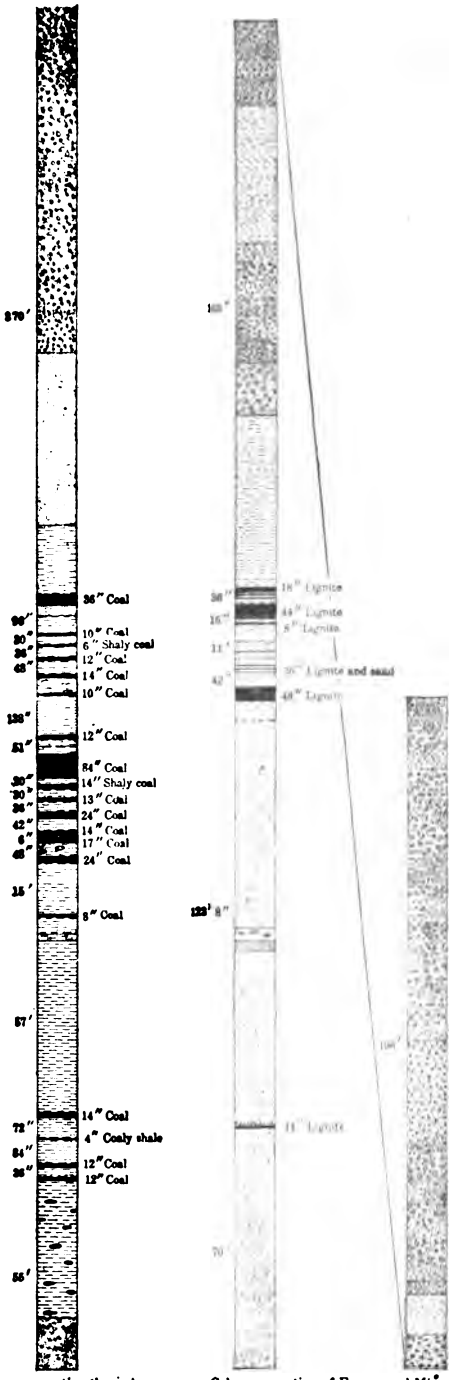


FIGURE 14.—Columnar section of the coal measures at Herendeen Bay and Coal Harbor.

Lower Cretaceous rocks, and is overlain by Eocene beds (figs. 13 and 14). A great faunal break is indicated by the paleontologic material obtained from the Lower Cretaceous and Upper Cretaceous rocks of this region, and unconformity may exist at the base of the Chignik formation. Such unconformity is not apparent within the coal field, however. The relationship of the Eocene (Kenai formation) to the Chignik formation is that of conformity.

The lignite-bearing beds of this field are of Eocene age, and belong to the Kenai formation. They rest conformably upon the Chignik formation (Upper Cretaceous), and in the vicinity of the coal field are related by unconformity to the Miocene beds.

STRUCTURE.

The coal field is located in the minor folds northwest of the main anticlinal arch of the Alaska Peninsula. The sedimentary formations exposed range in age from Upper Jurassic through Lower and Upper Cretaceous to Miocene. (See Pl. VIII, p. 42.) Pleistocene deposits mantle a small part of the area, and in the valley bottoms and along the shores there are alluvial deposits of post-Pleistocene age.

In the western part of the field, where the coal locations have been made, the formations have not been modified by volcanic intrusions or extrusions, but at the eastern margin of the field dikes vast quantities of volcanic tuffs, and extensive lava flows are numerous. Four volcanic centers, from which lava flows and fragmental

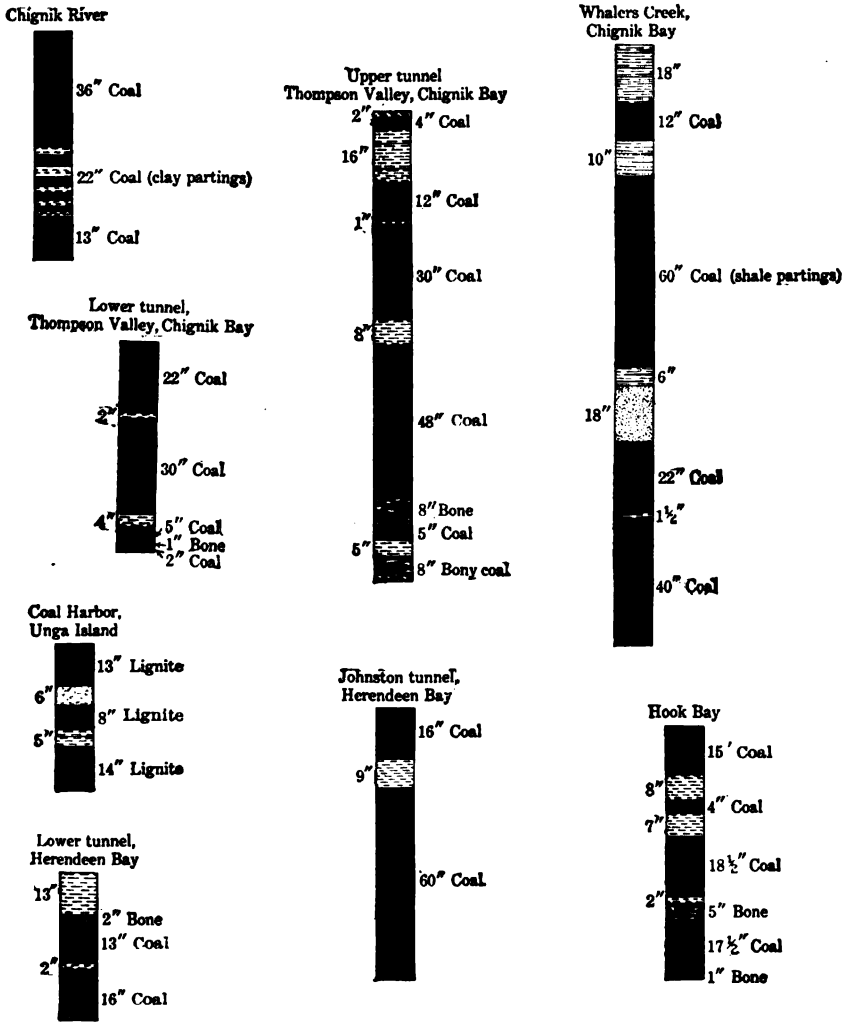


FIGURE 15.—Sections of coal seams in the Chignik Bay and Herendeen Bay fields and at Coal Harbor.

material issued, are situated near the eastern margin of the field. At the northern margin and along Herendeen Bay there are volcanic tuffs, but they are not so associated with the coal as to be significant. The northwestern portion of the small peninsula in which the coal is located is mantled in part by glacial material and in part by recent alluvium.

The central part of the field has a synclinal structure, with the axis plunging westward. North of this fold there is a broad anticline. Several small faults were noted within the coal field, and one fault contact at the southern margin indicates a throw of no less than 1,000 feet. These faults may be detected by the shifted outcrops exposed in the higher portions of the field, where there is little or no vegetation. Numerous minor faults, of the same general nature as the major faults shown on the surface, may be detected in the mine tunnels. The general structural conditions along a nearly north-south line through the coal field are shown in figure 13, and a general description of the geologic structure of this portion of the peninsula is given on pages 27 to 38.

THE COAL MEASURES.

The best-known outcrops in the coal field are near the head of Coal Valley and in the valley of Mine Creek. Coal is also exposed near the head of the next valley east of Coal Valley and at several places about the margin of the volcanic tuffs a little farther east, while still other outcrops have been reported in tributaries to Lawrence Creek. The main coal measures outcrop on the east shore of Herendeen Bay, about 5 miles north of Mine Harbor, in a locality known as Coal Bluff. Two beds of lignite have been found on the north coast of the coal-bearing peninsula, about 9 miles east of Point Divide, and several other seams of lignite are exposed on the west shore of Herendeen Bay, nearly opposite Coal Bluff. Columnar sections of these coals are given in figure 15.

The following section in the coal measures was obtained on the south slope of the Mine Creek valley:

Section in coal measures, Mine Creek valley, Herendeen Bay.

	Ft.	In.
Conglomerate	300	
Sandstone, coarse, cross-bedded, with huge sandstone concretions weathering brown from abundance of limonite	50	
Sandy shale	20	
Coal seam, medium grade	3	
Sandstone, firm, cross-bedded, with fossil leaves	3	
Shale	5	
Coal		10
Shale	2	6
Shaly coal		6
Shale, with sandstone cones	3	
Coal	1	
Shales	4	
Coal	1	2
Shaly sandstone, with sandstone cones	4	
Coal		10
Shales	4	
Coaly shales	1	6
Shales	3	

	Ft.	in.
Carbonaceous shales	1	
Shales	2	
Coal	1	
Shales	2	
Coaly shales, with shale partings	2	3
Coal, with bony partings and shaly bed	7	
Shales	1	8
Shaly coal	1	2
Shale	2	6
Coal	1	1
Shales	3	
Coal	2	
Shales	3	6
Coal	1	2
Shales		6
Coal	1	5
Shales, with sandstone cones	4	
Coal	1	8
Shales and sandstone interbedded	15	
Coal		8
Shales	5	
Shaly sandstone	2	
Shales	50	
Coal	1	2
Shales	6	
Coaly shale		4
Shales	7	
Coal	1	
Shales	3	
Coal	1	
Shales, with sandstone cones	40	
Coarse cross-bedded sandstone and conglomerates	15	
Shales and sandstones.		

The dip of these measures is 30° N., and the strike N. 91° E.

On the left fork of Mine Creek Paige[1] measured the following section:

Section of coal beds on left fork of Mine Creek.

	Ft.	in.
Coal, crushed	7	
Shale	9	
Coal, bony	1	
Shale and sandstone	6	6
Coal, crushed		8
Coal, fairly solid (partly obscured by slide)	10	
Shale, carbonaceous	3	4
Covered by slide	20	
Coal with bone (details not observed)	12	
Shale and coal	4	
Coal	2	8
Shale	6	
Coal	3	
Remainder hidden by slide.		

[1] Paige, Sidney, The Herendeen Bay coal field: Bull. U. S. Geol. Survey No. 284, 1906, p. 107.

The detailed section of the coal exposed in the lower tunnel on Mine Creek is as follows:

Section of lower tunnel coal bed, Mine Creek, Herendeen Bay.

	Ft.	in.
Shale roof.		
1. Shaly coal	1	1
2. Bone		2
3. Coal	1	1
4. Shaly coal		2
5. Coal	1	4
Firm sandstone floor. Strike, N. 91° E.; dip, 30° N.		

A section of the coal at the Johnson tunnel, which is on the south slope of the Mine Creek valley about 870 feet above sea level, is as follows:

Section of the Johnson tunnel coal bed, Mine Creek, Herendeen Bay.

	Ft.	in.
Shale roof.		
1. Coal	1	4
2. Clay		9
3. Coal	5	
Clay floor. Strike, N. 101° E.; dip, 34° NE.		

Samples of coal, analyses of which appear on page 105, were taken from each of the above beds. No work had been done in the lower tunnel during the 10 months preceding the examination. Material from beds 1 to 5 in the above section was included in this sample (laboratory No. 6957). The Johnson tunnel had also been closed fully 10 months, but a sample (laboratory No. 6951) was procured from bed 3 in the above section.

The Johnson tunnel is about 100 feet long. The coal continues for about 75 feet, becomes much broken, and finally disappears through faulting. Some prospecting for the continuation of this bed has been done, but it has not yet been located. In drifting it has been necessary to use timber to support the roof. Of late, coal has been mined here for local consumption only, and the amount mined has been only a few tons each year.

The lower tunnel is located near the stream bed, 275 feet above sea level, and has been driven for 150 feet along the strike of the coal. The roof is firm, and no timbering was necessary except at the entrance. About 20 tons were taken from this drift in 1907 for use in drilling and for domestic purposes. The walls of the drift indicate minor faulting at various places, the movements ranging from a few inches up to a foot. The condition is typical of the distributive faulting associated with the larger movements in the field, and is of the same general character.

Three drill holes have been put down in the lowlands near the mouth of Mine Creek, in the deepest, which reached a depth of 350

feet, thin strata of coal were found. The other holes were sunk 150 feet and 28 feet. The work was delayed by the loss of tools. As yet no coal of minable thickness has been found by drilling.

The coal exposed at Coal Bluff appears at the surface to be of as high grade as that outcropping at several other places. The coal exposed near the headwaters of Coal Creek, in certain of the tributaries from the west, and in the continuation in the opposite side of the syncline of the coal belt in which the Johnson tunnel is located, appears to be of good grade and faulting has not so greatly disturbed the formations in this part of the field. During the writer's visit, however, this part of the field contained so much snow that the coals could not be satisfactorily examined.

CHARACTER OF THE COAL.

PHYSICAL PROPERTIES.

In the tunnels the coal is generally very firm and nowhere badly shattered. Even in places where mining work had been abandoned nearly a year little loose material had fallen from the seam, though in such places the coal, which in the regular work of mining would probably come out in large blocks, could be readily worked out with a pick in lumps 4 to 5 inches in diameter. Thin bony streaks and fine shale partings, though not conspicuous, indicate on close examination the bedded structure of the coal. The coal in the lower tunnel in Mine Creek is of medium hardness, is firm and bright, and possesses the physical properties characteristic of a good grade of bituminous coal. Several tons of coal had been mined and stacked near the entrance to Johnson tunnel during the previous summer. This coal had been exposed to rains, to the waters from melting snows, and to changes in temperature throughout the year. It was not directly exposed to the sun's rays, however, and had not slacked badly.

The surface of the coal, in the exposures where tunnels have not been made, although it has been exposed to the processes of weathering for at least many years, has not been much affected. Where the seams were uncovered by shoveling away snow the coal was found to be in a firm, hard condition, but in such places the processes of weathering have emphasized the bedded structure of the coal seam. High elevations on the mountain side, where the coal outcrops in parallel ridges, the black bands often project in such form as to indicate that the coal is more resistant to the processes of weathering than the shales associated with it. The fuel in these exposures has the properties of true bituminous coal.

The lignites exposed east of Point Divide, on the west side of Herendeen Bay, and in the central portion of the peninsula east of the trail to Balboa Bay are soft and of dull black or brown colors.

The seams are divided by numerous shaly partings, and the amount of black shale in each seam is so great that this material will probably not prove to be of much commercial value.

COMBUSTION.

Coal from the Mine Creek tunnels was used during the field season in cookstoves. It burned with a medium-length yellow flame and with little smoke, the length of the flame and the amount of smoke being least in coal from the Johnson tunnel. The coal from these tunnels fuses and cakes somewhat on beginning to burn. The ashes are soft and fine, with but little clinker. No combustion tests were made from the coal outcrops where no mining had been done.

CHEMICAL AND CALORIMETRIC PROPERTIES.

Methods of sampling.—In collecting samples from this field positions were selected where complete and characteristic sections of the beds were exposed and where the effects of weathering were as slight as possible. In the tunnel the position selected was near the place where the work of mining had been discontinued. A fresh cut was then made across the bed from roof to floor, cleaning off the dirt and weathered coal as far as possible. A waterproof cloth was spread to catch the coal and a sample, including all parts of the bed except such shale and other bedded impurities as could readily be separated in the ordinary practices of actual mining, was cut from the roof to the floor. The sample was then pulverized and carefully quartered. A 3-pound sample prepared in this way was sealed at once in an air-tight can, which was not opened until the coal was analyzed.

Methods of analysis.—The samples collected were analyzed by F. M. Stanton, of the United States Geological Survey, using the standard methods [1] adopted in that work at the fuel-testing plant.

Analyses.—The following table gives the results of the proximate analyses of some of the coals from the Herendeen Bay, Chignik Bay, and Unga Island fields. The analyses of the coal as received have been recalculated to obtain the analyses on the air-dried basis. The samples were obtained at the following localities:

6952. Coal bed on west side of main stream, 7 miles northwest of Hook Bay, east side of Chignik Bay, Alaska Peninsula.
6956. Chignik Bay, Thompson Valley, three-fourths of a mile above mouth of stream.
6955. Chignik Lagoon, Whalers Creek, three-fourths of a mile above mouth.
6953. Chignik River, north side, 2 miles below Chignik Lake.
6957. Herendeen Bay, Mine Creek, three-fourths of a mile above mouth.
6951. Herendeen Bay, Mine Creek, 1¼ miles above mouth.
6954. Unga Island, Coal Harbor, 1¼ miles west-northwest of Gull Island.

[1] Bull. U. S. Geol. Survey No. 261, 1905, pp. 19-20; Prof. Paper U. S. Geol. Survey No. 48, 1906, pt. 1, 177-193; Bull. U. S. Geol. Survey No. 290, 1906, pp. 29-30.

Analyses of Chignik Bay, Herendeen Bay, and Unga Island coals.

[Analyses by F. M. Stanton, U. S. Geological Survey.]

SAMPLES AS RECEIVED.

Lab. No.	Locality.	Proximate analyses.				Ultimate analyses.					Calorific value.	
		Loss on air drying.	Total moisture.	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
6952	Chignik Bay	4.00	5.07	27.24	42.42	25.27	2.26	4.53	55.76	0.59	8.38	5,618	10,112
6956	.....do	6.50	10.77	30.37	43.99	14.87	.70	4.98	55.27	.61	23.57	5,356	9,641
6955	.....do	2.50	5.02	34.28	45.45	15.25	1.75	4.87	62.04	.56	15.53	6,245	11,241
6953	.....do	5.20	7.06	31.48	39.68	21.78	1.30	4.83	55.14	.61	16.34	5,470	9,846
6957	Herendeen Bay	4.60	7.48	32.13	48.77	11.62	.31	5.11	63.49	.91	18.56	6,256	11,261
6951	.....do	5.30	8.01	33.53	51.35	7.11	.41	5.41	66.44	.80	19.83	6,547	11,785
6954	Unga Island	12.50	23.27	25.42	25.13	26.18	.53	5.27	34.76	.52	32.74	3,227	5,809

AIR-DRIED SAMPLES (CALCULATED FROM TABLE ABOVE).

Lab. No.	Locality.	Proximate analyses.				Ultimate analyses.					Calorific value.	
		Moisture.	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Hydrogen.	Carbon.	Nitrogen.	Oxygen.	Calories.	British thermal units.
6952	Chignik Bay	1.11	28.38	44.19	26.32	2.35	4.26	58.08	0.61	8.38	5,852	10,533
6956	.....do	4.57	32.48	47.05	15.90	.75	4.56	59.11	.65	19.03	5,728	10,310
6955	.....do	2.58	35.16	46.62	15.64	1.79	4.71	63.63	.57	13.66	6,405	11,529
6953	.....do	1.96	33.21	41.86	22.97	1.37	4.48	58.17	.64	12.37	5,770	10,386
6957	Herendeen Bay	3.02	33.68	51.12	12.18	.32	4.82	66.55	.95	15.18	6,558	11,804
6951	.....do	2.86	35.41	54.22	7.51	.43	5.09	70.16	.84	15.97	6,913	12.343
6954	Unga Island	12.31	29.05	28.72	29.92	.60	4.44	39.73	.59	24.72	3,688	6,638

PROSPECTIVE MINING CONDITIONS.

POSITION OF THE COAL MEASURES.

Mining conditions are not especially difficult in the portion of the field where work has already been done. The coal outcrops at elevations ranging from sea level to at least 1,200 feet above sea level. Coal may be easily taken to tidewater from the lower drift in Mine Creek. A good horse trail now leads to the mouth of this tunnel, and it would not be difficult to construct a wagon road or railroad to that point. The Johnson tunnel, which is driven at an elevation of 870 feet, is less favorably located for transporting coal. The horse trail to the lower tunnel reaches this higher opening as well, but the ascent is for a part of the way difficult, though coal has been packed out on horses over the trail. The construction of a road from this opening would be expensive, but the coal might easily be carried by tramways to more accessible places in the valley. The exposures near the head of Coal Valley are at elevations of 1,000 to 1,200 feet above sea level. Coal is exposed in Coal Bluff, on the east side of Herendeen Bay, from sea level to the top of the bluff, an elevation of about 50 feet. The lignite exposures east of Point Divide and those on the west side of Herendeen Bay are in the cliff bordering the beach, and the lignite seams along the trail to Balboa Bay at elevations between 600 and 800 feet above sea level.

In the portion of the field where the bituminous coal occurs there is evidently a large supply of high-grade fuel above sea level. The structure is such at two places that the coal may be expected to pass below sea level, but it is not safe to conclude that there is any large supply of coal below sea level.

DIP OF THE COAL MEASURES.

The coal seams exposed in Mine Creek dip at angles varying from 25° to 35°, and on two sides of a westward-plunging synclinal fold, of which the axis coincides approximately with Mine Creek. At the head of Coal Valley the coal seams rest at angles of 13° to 20°. At Coal Bluff the dip of the coal measures is 31°. The lignite-bearing beds east of Point Divide extend at an angle of about 22°, and those on the west side of Herendeen Bay have dips of 31° to 46°. The lignite beds in the central portion of the peninsula rest at angles of 22°. The faulting that has distributed the formations has not been on a large scale, and when the structure is worked out in detail there should not be much difficulty in locating the coal in the different fault blocks. The exposures are so good in this field that a detailed survey on a large scale would furnish data for estimating with a high degree of accuracy the actual amount of coal in each portion of the field, and would probably make it possible to estimate the positions of the less broken portions of the coal.

EXTENT OF THE COAL MEASURES.

When the writer was at work in this field there was, unfortunately, a heavy covering of snow over portions where coal measures must exist, but in spite of these conditions the coal measures were traced eastward from Herendeen Bay to a point within a few miles of Port Moller, where they were found to pass beneath recent volcanic rocks. Since coal has been found at the same geologic horizon in the Chignik Bay region, and is there exposed for many miles, it is reasonable to suppose that there may be other exposures of this coal-bearing formation in the region between Port Moller and Chignik Bay, a part of the peninsula that is not yet surveyed. The lignite-bearing formation on the west side of Herendeen Bay is reported to continue far to the westward, but work was not carried on in that direction.

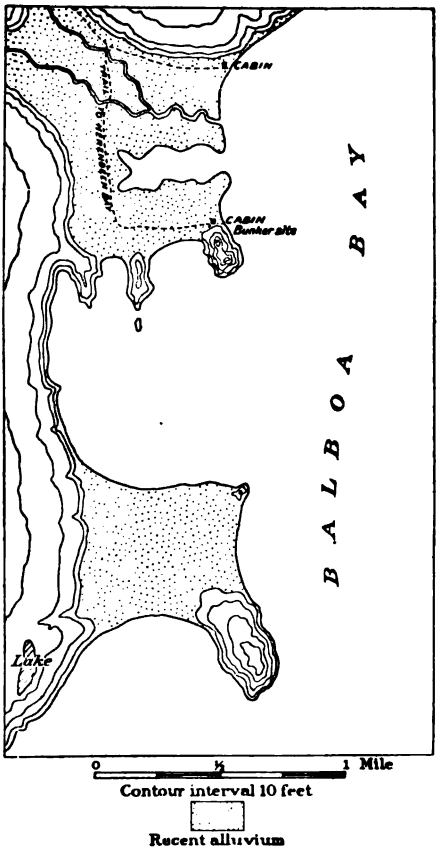


FIGURE 16.—Sketch map of the shore features near the head of Balboa Bay, which has been selected as a railroad terminus.

SHIPMENT.

If these coals are mined on a large scale, they should be carried by railway to Balboa Bay for shipment (fig. 16). The route from Mine Harbor to Balboa Bay is about 16 miles long and an easy one for railway construction. Mine Harbor is well protected and is deep enough for commercial purposes, but for several months each year Mine Harbor and the upper part of Herendeen Bay are locked in ice. Coal could be shipped during the summer by way of Herendeen Bay to Bering Sea and thence to Alaskan ports farther north. If coal is mined from the head of Coal Valley, the problem of taking it to tidewater on the Pacific side of the peninsula is a little more difficult. A railroad could be constructed along Coal Valley and connected with Mine Harbor by a circuitous route, which would add about 15

miles to the direct route and double the length of the haul to the Pacific. At Balboa Bay an excellent harbor and good bunker sites are available (fig. 16).

CHIGNIK BAY COAL FIELD.

GEOGRAPHY.

Chignik Bay lies on the Pacific side of Alaska Peninsula, in longitude 158° west and latitude 56° 20′ north. (See Pl. VI, in pocket.) The coal belt stretches from Chignik River, on the southwest, toward the northeast, beyond the head of Hook Bay, and parallels the western shore of Chignik Bay for a distance of at least 30 miles. (See Pl. VII, p. 40.)

A small reentrant on the south shore of Chignik Bay, known as Anchorage Bay (Pl. XI, *B*, p. 86), provides an excellent harbor, and beside this bay the Chignik post office is located. A small steamer from Seward calls at this port once each month. Chignik Lagoon and Mallard Duck Bay, to the west, are nearly cut off from the larger body of water by a sand and gravel spit. A sand bar at the entrance makes the inner harbor unavailable for boats drawing more than 12 feet of water. An irregular channel leads through the lagoon to the mouth of Chignik River, but the larger portion of the lagoon is dry at low tide. Chignik River furnishes a water route to a chain of lakes in the central part of the peninsula, and from these lakes small boats may, after a short portage, descend to Bering Sea. Boats drawing more than 2 feet of water can not safely navigate the Chignik except at high tide, when small launches drawing barges can ascend the river as far as the coal mine.

Hook Bay lies near the north entrance to Chignik Bay. It is bordered in part by alluvial lands and in part by rugged cliffs. The sheltered waters on the south side of Hook Bay afford an excellent harbor (Pl. XIII, *A*).

The area underlain by coal west of Chignik Bay is on the southeast slope of the main mountain belt of the peninsula. The summits reach elevations of about 2,500 feet, and the broad anticlinal structure gives long, gentle slopes to the mountains. A series of nearly parallel valleys of open U-shaped forms cross from the summit region to the margin of Chignik Lagoon and Chignik Bay. In these valleys and in the intervalley areas, above the heavy covering of grasses and mosses, the formations are well exposed.

The winter snows do not leave the lower lands until April or May. During the summer there is considerable rain and much cloudy weather, and by the latter part of September fresh snows begin to appear on the mountains. The climatic conditions from April to October are not, however, such as to interfere with out-of-door work.

A. HOOK BAY, NEAR NORTH ENTRANCE TO CHIGNIK BAY.

This is the nearest harbor to the coal prospects northwest of this bay. The lowland at the left has been selected for a town site. See pages 93, 108, 114.

B. EXPOSURE IN THE UPPER COAL SEAM IN THOMPSON VALLEY.

See page 112.

The Alaska Packers' Association has a cannery in this region, on the south shore of Chignik Lagoon, and the Northwestern Fisheries Co. one at Anchorage Bay.

Development work in this field has been described on page 20 of this report.

AREAL EXTENT.

The actual known extent of coal in this field does not exceed 15 square miles, but from the distribution of the coal outcrops and the general geologic structure in the field it is probable that coal underlies an area of between 40 and 50 square miles.

A few thin lignite seams occur in the Kenai formation on the southwest side of Chignik Bay. The areal extent of these lignite seams will probably be found to be between 10 and 20 square miles, but the quality of this material is not such as to make it of economic value.

GEOLOGY.

STRATIGRAPHY.

The bituminous coal in the Chignik Bay region is of Upper Cretaceous age and belongs to the Chignik formation. The coal measures occur in the middle portion of that formation, and are underlain and overlain by thin beds of sandstones and shales. The Upper Cretaceous (Chignik formation) in this region rests unconformably upon the Upper Jurassic (Naknek formation), but it is overlain conformably by the Kenai formation, of Eocene age. This section is shown along Chignik River and along the shores of Chignik Lagoon.

STRUCTURE.

The sedimentary series in this coal field is known to include Jurassic, Upper Cretaceous, and Eocene rocks. The absence of Lower Cretaceous fossils in the collections procured in this region is remarkable, for that horizon is well represented at Herendeen Bay, about 100 miles west. A description of the sedimentary formations of this portion of the peninsula is given on pages 29 to 84.

The structure of the central part of the peninsula is that of a broad anticline, the axis of which extends at least as far southwest as Pavlof Bay. In this region the axis of the fold passes northwest of Chignik Bay through Chignik Lake, and thence northeast along the crest line of the Aleutian Range. East of Chignik Lagoon and along the south shore of Chignik Bay the sedimentary strata are gently folded and somewhat faulted. Near the upper limit of the sedimentary rocks the number of intruded sheets of lava increases notably until at last the sediments are succeeded by vast flows of lava. Great quantities of fragmental material have been erupted, and large streams of lavas outpoured from two or three former

centers of volcanic eruption in the vicinity of Hook Bay, and as a result large blocks of sedimentary formations have been disturbed.

A great mass of igneous rocks, chiefly andesites and basalts, lies south of a line passing through Chignik Lagoon and west of Anchorage Bay. Basaltic dikes are common in the area bordering these igneous rocks. South of Anchorage Bay there is a huge mass of dacitic rock, with which apparently are associated a number of sills. Other sills are well exposed on the north shore of Anchorage Bay, while similar masses of dacite occur in the vicinity of Hook Bay. Only in the extreme northeastern and southwestern parts of the coal belt do igneous rocks come into close contact with the coal, and in those places the coal does not appear to have been affected by the igneous activities.

The structure in this field is much simpler than that near Herendeen Bay, and detailed geologic work will readily determine the amount and distribution of the coal.

THE COAL MEASURES.

The formation that contains the bituminous coal in this region is of Upper Cretaceous age. It is well exposed in the Chignik Bay region and has therefore been named the Chignik formation. The known and probable distribution of the Chignik formation in the vicinity of the bay of that name has been indicated on Plate VII. The same formation, however, is known farther to the northeast and to the southwest (Pl. VI, in pocket), and it is very probable that outcrops occur in the intervening unsurveyed portions of the peninsula. The coal measures consist of sandstones, shales, and conglomerates, interstratified with the coal seams.

The developed coals are at Chignik River, Whalers Creek, Thompson River, and northwest of Hook Bay. Some detailed sections of these coals are given in figure 15, and a description of each locality will be given in the following paragraphs.

Chignik River.—The coal bed that has been worked outcrops on the river bluff 3 miles above the head of Chignik Lagoon (Pl. XIV, *A*), and has been traced inland for a little more than half a mile. At this locality it strikes N. 2° E. and dips 24° E. A section of the bed measured in the drift is as follows:

Section of Chignik River coal bed.

	Ft.	In.
Dry bone, with thin coal streaks		3
Coal		6
Coal and dirt		8
Coal	1	
Bony coal	1	5
Coal	1	4
	5	2

A. ENTRANCE TO CHIGNIK RIVER COAL MINE.

See page 110.

B. TUNNEL OPENING IN WHALERS CREEK COAL SEAM.

See page 111.

The roof, which is of shale with thin layers of coal overlain by sandstone, is very even. The floor, however, is not so regular, and the roll or swelling in it reduces the thickness of the bed at the end of the drift from 5 feet to 9 inches. It is possible that the roll, which is known to be rather long, may be narrow, and that a short tunnel driven through it would discover the full thickness of the coal bed on the other side.

The coal is solid and bright, and comes out in good-sized pieces. When used under a boiler it has to be stoked very frequently to keep it burning freely. It is a fairly satisfactory steaming coal when it is properly handled, but it makes a large amount of ash and the fires have to be cleaned often. An analysis of this coal is given on page 105.

The Chignik River mine is worked throughout the year by two men without machinery, the coal being undercut by hand and shot down. Coal outcrops appear at several other places on the north bank of Chignik River east of the mine, but the beds do not appear to be of as good grade as that at the mine and have not been worked as yet.

Whalers Creek.—Whalers Creek is a small stream entering Chignik Lagoon from the north, a short distance below the mouth of Chignik River. Coal is exposed for 600 feet along the northernmost of the three main branches of the creek, the exposure being along the strike of the coal measures, which outcrop at the coal mine on Chignik River. The strike of the coal is N. 5° E. and the dip is 22° E. The section of the coal is as follows:

Section of Whalers Creek coal bed.

		Ft.	In.
	Shaly sandstone roof.		
1.	Coaly shale		10
2.	Shale		8
3.	Coal	1	
4.	Coaly shale		4
5.	Sandy shale		7
6.	Coal with slate partings	5	
7.	Coaly shale		6
8.	Sandstone	1	6
9.	Coal	1	10
10.	Shaly coal		1½
11.	Coal	3	4
	Sandy shale floor.		

The slope, which has been driven 130 feet on the coal, follows the lower part of the bed and includes the strata numbered 8 to 11 in the above section (Pl. XIV, *B*). The coal bed (Nos. 9 to 11) was sampled in the usual way and analyzed, with the result given on page 105 (laboratory No. 6955).

The coal is bright, black, and blocky, very much like that mined at Chignik River, but at this locality the section of the coal is better in that the partings are thin. A nearly vertical fault, about 500 feet downstream from the mine opening, probably cuts off the coal bed. On the upstream side, about 40 feet from the opening, a vertical fault throws the coal down 6 feet, and 115 feet upstream from the mine another fault, which cuts off the coal, has been reported. This upper portion of the valley was filled with snow when the region was visited by the writer.

Although faults have disturbed the coal somewhat, there appears, nevertheless, to be a very considerable body of good coal available. The location of this coal favors shipment on small boats down Chignik Lagoon or by rail. A railway might be built across Chignik River a short distance above the mouth and thence across a lowland area to the head of Kuiukta Bay, where excellent harbor facilities are reported. The distance from Whalers Creek to the head of Kuiukta Bay by the proposed railway route is about 5 miles.

Coal has been reported to outcrop at several places high on the mountain slopes northeast of the outcrops of coal in Whalers Creek. The localities pointed out in the field by prospectors are along the general strike of the coal measures and presumably contain the same beds that are exposed elsewhere in the field.

Thompson Valley.—Thompson Valley lies northwest of the northern portion of Chignik Bay, and is a broad, open, flat-bottomed valley, heading among the high mountains at least 10 miles from the beach. Coal is exposed on the northeastern slope 1¾ miles from the beach and 300 feet above the valley floor (Pl. XIII, *B*, p. 108). The strike of the beds is N. 61° E. and the dip is 21° NW. Two workable coal beds are exposed for at least a mile, and their extent is probably much greater. Where the tributary streams to Thompson Valley cross these coals there are falls or cascades in their courses. The detailed measurements of these beds are given below:

Sections of coal beds in Thompson Valley.

Lower bed.

		Ft.	In.
	Sandy shale roof.		
1.	Coal	1	8
2.	Shale parting		2
3.	Coal	2	6
4.	Coaly shale		4
5.	Coal		5
6.	Bone		1
7.	Coal		2
	Sandstone floor.		

Upper bed.

	Ft.	in.
Cross-bedded sandstone roof.		
1. Clay		2
2. Coal		4
3. Coaly shale		4
4. Shale		8
5. Coaly shale		4
6. Coal		12
7. Clay parting		1
8. Coal	2	6
9. Coaly shale		8
10. Coal	4	
11. Bone		8
12. Coal		5
13. Shale		5
14. Bony coal		8

The analysis of a sample taken from the beds numbered 6, 8, and 10 in the foregoing section of the upper coal is given on page 105 (laboratory No. 6956).

A large body of good coal is available at this locality. The conditions for mining are favorable, and the space at the base of the bluff is ample for mine buildings and mine bunkers. The chief difficulty in the way of exploiting this coal is in making arrangements for shipping. The beach at the mouth of Thompson Valley is exposed to the severe storms from the Pacific Ocean. A railway from the valley to Chignik Lagoon could be easily built, for the route would be over a lowland area and not more than 9 miles in length. The conditions in Chignik Lagoon, however, are not favorable for loading large ocean-going vessels. Hence it would probably be necessary to continue the railway along the northwest shore of the lagoon and then by the same route as that from Whalers Creek to the head of Kuiukta Bay, as already described.

Hook Bay.—Hook Bay is in the northern part of the field examined. The coal in this vicinity occurs near the headwaters of the right-hand branch of the stream entering Hook Bay from the west and in the foothills of the main mountain range. The general strike of the beds is N. 11° E. and the dip 34° E. The section of the coal is as follows:

Section of Hook Bay coal bed.

	Ft.	in.
Firm sandstone roof.		
1. Coal	1	3
2. Clay		8
3. Coal		4
4. Clay		7
5. Coal	1	6½
6. Clay parting		2
7. Bony coal		5
8. Coal	1	5½
9. Bone		1
Shale floor.		

Above this bed is an 8-foot bed of sandstone overlain by a thin layer of coal. Below the main bed of coal lies a 4-foot layer of shaly sandstone, underlain by a 3-foot bed of coal, in the middle of which is a 6-inch parting of shale. The exposures in the tunnel show the coal to be uniform in thickness and quality.

In sampling this bed a cut was made across Nos. 5 to 8, inclusive, in the above section. The analysis is given on page 105 (laboratory No. 6952).

The strike, so far as the beds could be examined, is uniform, and appears to continue without notable break for at least half a mile to the northeast. The tunnel opening is 50 feet above the stream bottom, where there is space for mine buildings. At present there is a wagon rood from Hook Bay to the coal croppings, along a stream bottom where the general gradient and space would be favorable to railway construction. Hook Bay is an excellent small harbor (Pl. XIII, *A*, p. 108), and is bordered by favorable sites for wharves and bunkers. The distance from the harbor to the coal is about 8 miles. At present four claims are staked out in this field, and development work is being done under the auspices of the Alaska Peninsula Mining & Trading Co.

CHARACTER OF THE COAL

PHYSICAL PROPERTIES.

The coal from the Chignik River mine is bright black and of medium hardness. It is worked out in lumps ranging up to 10 and 12 inches in diameter. The seam, as exposed late in the season, of 1908, showed some crushing at the front wall and at the end of the tunnel. The section in the mine shows sufficient shale partings and bony streaks to indicate the general bedded structure of the coal, which corresponds to the general dip of the formations in that part of the field. The coal, when taken from the mine, is dumped upon a barge near the entrance of the tunnel, and is unloaded from the barge and dumped into the coal bins at the cannery, where it is used. In the processes of handling, the coal usually becomes broken into fragments ranging up to 3 or 4 inches in diameter. This coal does not appear to slack badly. The best exposures in Whalers Creek are in a prospecting tunnel, where the coal seam is firm and the bedded structure pronounced, the structure being emphasized by certain shale partings. The coal is a dull black on the weathered surfaces, but is bright in fresh exposures. The Thompson Valley exposures are only a little beneath the surface, and not beyond the zone of weathering. This coal, however, is in a heavy firm bed, more resistent than the shales and sandstones associated with it, as is indicated by the rapids or falls where streams cross the coal seam.

In the short tunnel in the coal northwest from the head of Hook Bay, the coal is in seams 18 inches or less in thickness, separated by thin beds of shale. These shale partings indicate the general bedded condition of the sediments, and correspond with the general dip of the strata. The upper portion of the seam is bright and black, and of medium hardness, and appears to be a high grade of bituminous coal. The lower portion of the seam has more bony streaks, but would average a fair grade of bituminous coal.

COMBUSTION.

The burning of the coal from the Chignik River mine was observed under the boiler of a small steam tug. The flame was distinctly yellow and the coal burned freely, but there was a large proportion of ash and some clinkering. The fireman on the tug complained that this coal does not hold the fire well. Persons who have used the coal estimate that there is about 25 per cent ash in the coal as it comes from the mine. The coal from the other exposures in the Chignik Bay region is not as yet in use.

CHEMICAL AND CALORIMETRIC PROPERTIES.

It was customary to select a position where a complete and characteristic section of the bed was exposed in sampling the coal seams in the various portions of this field, and accordingly, where tunnels had been driven, the positions selected were at or near the face of the tunnel. An effort was made to remove from the surface the loose and weathered portion of the coal seam where no tunneling had been done, but it was not practicable to go beneath the zone which had been affected by surface weathering, and it is probable that the coal will run a little better than is indicated by the samples taken. The samples were cut from the roof to the floor and prepared in the usual way (see p. 104) for the laboratory.

Each sample was analyzed by F. M. Stanton, of the United States Geological Survey, by the standard methods adopted in that work. The analyses of these samples are given in the table on page 105.

PROSPECTIVE MINING CONDITIONS.

POSITION OF THE COAL MEASURES.

The coal in this field is known to outcrop from approximately sea level to elevations between 500 and 600 feet above the sea. Prospectors report higher outcrops on the mountains, where the elevations must be as much as 1,500 or 2,000 feet, and the structure in the range is such as to make the occurrence of these reported outcrops very probable. If the same seams of coal outcropping in the lower country extend to such elevations on the mountains,

the quantity of coal in this field is much larger than has been estimated by the writer. The coal measures may possibly pass below Chignik Bay, but the amount of coal above sea level will probably supply the demand from this field for many years, and is certainly sufficient to encourage large mining enterprises.

DIP AND EXTENT OF THE COAL.

The coal seams in this field rest on the southeast flank of the main anticlinal fold of the Aleutian Range, and vary in dip from 21° to 43°. From Chignik River the coal seam now being mined has been traced eastward for a little less than a mile. It is apparent from the exposures in Whalers Creek that coal is there continuous for about a mile, but the position and structure is such as to suggest that the coal seam in the Whalers Creek claim is the same as that exposed at the mine on Chignik River. The distance from Whalers Creek to Thompson Valley is about 15 miles, but that portion of the field has not been examined. The exposures in Thompson Valley indicate that the coal is continuous over several square miles, and there is a strong suggestion that these coals may, when further work is done on them, be found essentially continuous with those to the southwest near Chignik River. The Hook Bay locality is about 8 miles from Thompson Valley, along the general strike of the coal measures. The exposures on the Hook Bay claims are reported to extend along the strike to the northeast for at least a mile, and detailed work may connect those seams with those already described. Still farther to the northeast, on the shores of Aniakchak Bay, coal is reported, but from verbal descriptions that coal appears to be lignite, and may prove of Kenai (Eocene) age rather than of Chignik (Upper Cretaceous) age. Small areas of the Kenai formation may be expected to occur at various places along the peninsula.

SHIPMENT.

The shipment of coal from the Chignik Bay field is somewhat difficult, because Chignik Bay and Chignik Lagoon do not offer good harbor facilities. Vessels of deep draft can not enter Chignik Lagoon, and there is no protection along the southwest side of Chignik Bay near the coal field. The cannery vessels receive their cargoes in Anchorage Bay, to which point the fish are brought in small boats or barges from the lagoon. A method of handling coal involving such transfers would be too expensive, and therefore a harbor must be sought to which coal can be brought directly from the mines. Hook Bay furnishes such a harbor for the northeastern portion of the field, and a railway could be constructed from Thompson Valley to Hook Bay without encountering any great engineering difficulties. The harbor most favorably considered by those now interested in this

coal, however, is at the head of Kuiukta Bay, locally known as Dorenoi Bay. The entrance to this bay is a few miles southwest from Prospect Bay, which is shown in Plate VII (p. 40), but the head of Kuiukta Bay is only a little more than 5 miles from the shores of Chignik Lagoon. The pass from Chignik Lagoon to the head of Kuiukta Bay is through a broad, open valley, practically at sea level. It is proposed that a railroad be constructed from the coal field northwest of Chignik Lagoon to a narrow place in Chignik River, where a bridge may be built, and thence by way of the low pass to the head of Kuiukta Bay. A railroad could be constructed along the northwest side of Chignik Bay and Chignik Lagoon to receive the coal from the different portions of the field. The distance from the Chignik River coal mine to the head of Kuiukta Bay by the proposed route is about 9 miles. From Whalers Creek to Kuiukta Bay the railroad route would be about 15 miles. If Thompson Valley coal was carried by rail to Kuiukta Bay by way of a bridge across Chignik River, the haul would be between 30 and 35 miles. Kuiukta Bay was not visited by the writer, but the local boatman in the employ of the survey during the season of 1908 and the captain of the *Dora*, the one passenger vessel that regularly visits this coast, report the bay to have excellent harbor conditions near the head.

COAL HARBOR COAL FIELD.

GEOGRAPHY.

Unga Island is the largest and westernmost island of the Shumagin Group, which lies southeast of Balboa Bay. The greater portion of the island is mountainous, but the northern end has a rolling topography, its highest elevation being about 600 feet above sea level (Pl. II, p. 12). The northwestern portion of the island and a little strip along the west coast are known to contain the coal measures.

Unga Island has a milder and more equable climate than the mainland to the north. Practically all the winter snow disappears during the summer, and the number of clear days per year on the island exceeds the number for the mainland.

The northern portion of the island is overgrown by grasses and shrubs. A few patches of alder bushes are scattered on the valley slopes, but there are no trees.

There is a United States post office at Coal Harbor, and the passenger steamer which visits the coast calls at this port in each direction on its monthly voyages between Seward and points on the peninsula.

DEVELOPMENT WORK.

The development work that has been done in this field is described on page 19 of this report. A vertical section of the mine at Coal Harbor is given in figure 17.

AREAL EXTENT.

The coal measures occupy an area of 35 or 40 square miles. This entire area may contain coal similar to that exposed in the cliff at the east margin of the field, but no coal seams of ecomonic value were observed in the narrow strip along the west coast of the island.

GEOLOGY.

The coal measures in this field are of Eocene age and are a portion of the Kenai formation. The section is best exposed near the coal mine on the west shore of the Coal Harbor Inlet (fig. 14, p. 98). The formation rests in a slightly inclined position, and dips from 8° to 10°. W. The general strike of the beds is N. 12° W. The Kenai formation at

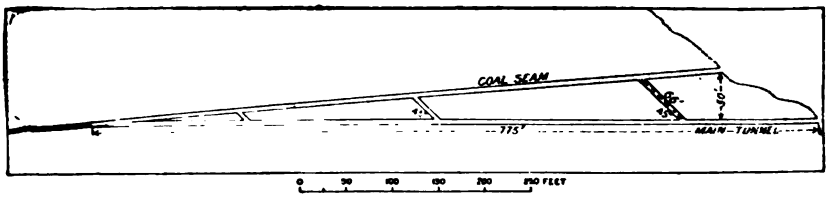


FIGURE 17.—Vertical section at Coal Harbor mine, Unga Island.

this locality is overlain conformably by the Unga conglomerate, which is of Miocene age (fig. 8, p. 66). The section measured on the cliff about one-half mile north of the coal mine is given below:

Section in upper Eocene and Miocene rocks at Coal Harbor, Unga Island.

	Ft.	in.
Miocene (Unga conglomerate):		
Conglomerate and grits at highest point in cliff	100	
Coarse, heavy, black agglomerate	30	
Grit and conglomerate	40	
Tuffs	4	
Sands and clays, alternating	12	
Volcanic tuff, gray	10	
Conglomerate and grits	25	
Sand and clay	40	
Coarse grits and conglomerate	35	
Conglomerate, with bowlders up to 3 feet in diameter	15	
Upper portion of Eocene (Kenai formation):		
Sand and clay	50	
Lignite	1	6
Sand, clay, and lignite in thin beds	3	
Clay		6
Lignite	3	
Clay		6
Lignite		8
Sandy clay	1	4
Lignite		8
Sand	4	
Clay and lignite parting	5	

Upper portion of Eocene (Kenai formation)—Continued.	Ft.	In.
Sand	2	
Lignite and sand, alternating	3	
Sand	3	
Lignite, with sand lenses	4	
Clay	6	
Sand	60	
Sand, with concretions	4	
Gravel	3	
Sand, cross-bedded	50	
Gravel		8
Lignite	1	2
Sand, cross-bedded	70	

The strike is north 10° west and the dip 9° west. The base of the section is 50 feet above mean tide level.

The coal measures, as is shown by the above section, are composed of sands, clays, gravels, and lignite, the materials being poorly cemented. No marine shells have been obtained from the coal measures, though the beds contain some plant remains, which have been described. (See p. 52.) The upper 200 feet in the measured section given above represents the Unga conglomerate at this locality. Shells of marine life have been secured from this formation, the beds of which consist chiefly of grits and conglomerates composed in part of volcanic materials.

CHARACTER OF THE COAL.

All the coal seen in this field is of lignitic character. The measured section indicates that, though seams are numerous, most of them are too thin to be of commercial value. The natives and white residents on the island and on some of the neighboring islands have prospected along certain of these thin seams and found some high-grade lignite in them, but the material does not occur in sufficient quantities to encourage development. The developed coal bed outcrops about 200 feet above tidewater. Detailed measurements of the upper part of the coal bed as now exposed in the mine are given in the following section:

Section of coal bed in Coal Harbor mine.

Firm, coarse grit, and conglomerate roof.	Ft.	In.
Lignite	1	1
Loose sand		6
Lignite		8
Coaly shale		2
Clay		3
Lignite	1	2
	3	10

Strike, N. 12° W.; dip, 8° W.

The bed was sampled in the usual way, the sand and shale, which could be readily separated in mining, being excluded. The analysis of the sample is given on page 105.

PROSPECTIVE MINING CONDITIONS.

The Unga seams of lignite incline westward from an elevation of about 200 feet at the east margin of the field and evidently pass below sea level before reaching the western margin of the island. The quantity of lignite above sea level, however, is probably sufficient to supply the demand for such material from this field for a long time. The beds rest at so low an angle that mining can be done in a very inexpensive way.

There are no special difficulties associated with the mining or shipment of this lignite, and if it is mined with sufficient care to keep it clean it may be able to compete with the somewhat better coals that are now being shipped to this part of Alaska. This lignite will at least continue to be of value to the natives and to the few white people living on Unga and the neighboring islands.[1]

PETROLEUM.

COLD BAY OIL FIELD.

GEOGRAPHY.

Petroleum is known to occur in the vicinity of Cold Bay. This region was not visited by the writer, but it was examined by Martin[2] during the summers of 1903 and 1904, and the following account is in part abstracted and in part quoted from his reports.

Cold Bay is located on the east side of the peninsula near the southern entrance to Shelikof Strait and about opposite the southwestern end of Kodiak Island. The bay is roughly triangular, about 10 miles long by 7 miles wide at the mouth, and contains a large area of deep water. It is a good harbor. (See Pl. VI, in pocket.) The surrounding country consists of an elevated upland with gently rounded or flat-topped hills rising above it, and its general level is about 750 feet above tide. The higher peaks rise to an elevation of about 1,500 feet, but farther back from the coast in the central part of the peninsula are mountains 5,000 feet or more in height. Among these is the volcano Peulik, a peak about 5,000 feet high, which is

[1] G. C. Martin analyzed the problem of the markets for Alaskan coal and published his report in Bull. U. S. Geol. Survey No. 335, pp. 95-112.

[2] Martin, G. C., Petroleum fields of the Pacific coast of Alaska: Bull. U. S. Geol. Survey No. 250, 1905, pp. 37-59; Notes on the petroleum fields of Alaska: Bull. U. S. Geol. Survey No. 259, pp. 133-138.

situated on the western shore of the southern arm of Becharof Lake, about 35 miles west of Cold Bay. This volcano is one of the chain that extends the entire length of the Alaska Peninsula and throughout the Aleutian Islands.

Timber is entirely lacking in this region, the only trees being a few small cottonwoods, willows, and scrub alders along the banks of the streams. The flat lowlands along the shores of Cold Bay are covered with deep grass, but the hillsides and upland region have no vegetation except scattered tufts of grass and moss.

GEOLOGY.

STRATIGRAPHY.

A general section of the rocks exposed in the Cold Bay Becharof Lake region is given below.[1]

General section in the Cold Bay-Becharof Lake region.

Name of formation.	Age.	Lithologic character.	Thickness in feet.
	Post-Jurassic	Volcanic rock, probably andesite or basalt.	
Naknek formation	Upper Jurassic	Arkose, conglomerate, sandstone, and shale.	3,000 to 5,000
"Enochkin formation"	Middle Jurassic	Shale, sandstone, and a little limestone.	2,000
	Triassic	Shale, limestone, and chert	
	Pre-Upper Jurassic	Granite, syenite, etc	

The coarse crystalline rocks (granite, syenite, and rocks of similar texture) occur in a belt that crosses the lower end of Becharof and Naknek lakes and possibly underlies the Cold Bay region.

Martin's report [2] on the petroleum of the Cold Bay district is as follows:

The Triassic rocks occur on Cape Kekurnoi at the eastern entrance to Cold Bay, and on some of the capes and islands to the northeast. They doubtless underlie the Jurassic throughout the Cold Bay region.

The Enochkin formation occupies both shores of Cold Bay except at the northeastern promontory (Cape Kekurnoi) and at the head of the bay. It also extends in a belt along the shore of Shelikof Strait from Cold Bay to Dry Bay and probably as far beyond as Portage Bay.

The Naknek formation forms the shore of the head of Cold Bay and occupies the entire interior region as far west as Becharof Lake and as far north as Katmai.

The post-Jurassic volcanic rocks occur in a discontinuous belt near the center of the peninsula. This belt includes several volcanoes which have been active in comparatively recent time. The lavas are probably all either andesite or basalt.

[1] From Bull. U. S. Geol. Survey No. 225, 1904, pp. 380-382; No. 250, 1905.

[2] Martin, G. C., Notes on the petroleum fields of Alaska: Bull. U. S. Geol. Survey No. 259, 1905, pp. 135-139.

paraffin oils. These paraffin oils contain a considerable quantity of solid paraffin. It was not practicable to determine the amount of the material with the small amount of oil at our disposal.

"The iodine absorption of the oils and distillates has been determined by Hanus's method (solution standing four hours) and the results are here tabulated:

Iodine absorption of oils and distillates.

	Per cent.
Burning oil	17.2
Lubricating oil	27.2
Heavy lubricating oil	35.2

"These iodine numbers upon the lubricating oils were obtained upon the samples. For comparison, samples of similar oils were obtained from the Standard Oil Co. and the iodine numbers determined as follows:

Light distillated lubricating oil (spindle oil)	32 per cent iodine.
Dark lubricating oil (engine oil)	45.4 per cent iodine.

"The burning oils were tested in a small lamp and found to give a good flame. All the oil was consumed without incrusting the wick or corroding the burner.

"The sample of crude oil from Cold Bay was distilled in such a way as to give the maximum yield of burning oil. Under these conditions 52.2 per cent of fair quality burning oil was obtained.

"The oils have paraffin bases, and the products of distillation are 'sweet.' We are informed that these samples are 'seepage oils.' If a sufficient yield can be obtained by drilling, a very suitable oil for refinery purposes may be expected, containing a very much larger quantity of the more desirable lighter products."

OTHER POSSIBLE PETROLEUM FIELDS.

A well at Dry Bay was drilled to a depth of 320 feet in the summer of 1902 without encountering oil. The tools were then lost and the hole was abandoned. In August, 1903, a new well was started in close proximity to the first, but not much was accomplished, and work was discontinued a few months later because of an accident to the machinery. Martin [1] says of other possible prospects:

Seepages are reported from the shores of Kamishak Bay, especially at Douglas River. The rocks in this region are shales, sandstones, and conglomerates of Jurassic age. They are the equivalent in age of the beds overlying the Enochkin formation in the region to the north already described. The rocks are here horizontal or have very gentle dips over large areas, and it would seem to be a promising region to prospect with the drill. If the Middle and Lower Jurassic rocks in the Enochkin or Cold Bay regions prove to contain oil in commercial quantity, it would seem that new fields might reasonably be expected on the coast at Douglas River and for 20 miles westward. This is, however, a difficult place to land machinery, for the bays are all shallow and filled with rocks, while numerous uncharted reefs extend out many miles from shore into Cook Inlet. The writer is, therefore, not inclined to encourage speculation here, at least until more encouraging news is received.

The geology of the coast between Douglas River and Katmai does not warrant in the slightest degree any petroleum prospecting. Along much of this coast are only volcanic and other crystalline rocks, in which the occurrence of petroleum is an absolute impossibility.

[1] Martin, G. C., Notes on the petroleum fields of Alaska; Bull. U. S. Geol. Survey No. 259, 1905, pp. 135-139.

GOLD.

POPOF ISLAND.

Placer gold was discovered by Louis Herman in the beach about 1½ miles south of Sand Point post office on Popof Island in the summer of 1904. (See Pl. VIII, p. 42.) Active work was in progress during 1904 and 1905, and it is reported that gold amounting in value to about $12,000 was taken from these beach placers in those years. The productive belt was about three-fourths of a mile long. From 20 to 40 men were at work during the summer of 1904 with rockers, washing the coarse sand and gravel. All the gold was found below mid-tide, and most of it around large bowlders at about the level of low tide. Little work has been done on this beach since 1905. In 1908 but one man was engaged in rewashing the sand and gravel, and he is reported to have found it unprofitable and finally to have abandoned operations.

During 1908, most of the interest on this island was centered on four lode claims that were staked on the hills immediately adjoining the beach placers. No distinct quartz ledges have been located, but the exposed rock contains some free gold. Specimens in which free gold is plainly visible may be found in the surface zone of oxidation and weathering. This zone varies from 5 to 10 feet in thickness. Several samples taken from the weathered material yielded some free gold when crushed and panned. The owners of this property have had several samples assayed, and values up to $20 a ton were reported as a result of the assays. On the Louis Herman property a short tunnel has been driven and four shafts have been sunk below the zone of surface weathering. Ore samples taken from three openings on this property varied greatly in content of gold; one sample was exceedingly rich. The rock in which this gold occurs is an andesite similar to that in Unga Island, where the Apollo mine is located. The unweathered rock appears as a light gray lava, containing an abundance of small pyrite crystals. In claim adjoining the Louis Herman property one small quartz ledge has been discovered and some development work has been done.

UNGA ISLAND.

Gold-bearing ledges have been found at a number of places in Unga Island. (See Pl. VIII, p. 42.) In the southeastern portion of the island, about 1 mile from the head of Delarof Harbor and 4 miles from the town of Unga, are located the Apollo and Sitka mines. A third mine has been opened on the Shumagin group of claims, near the head of Baralof or Squaw Harbor. Several locations for gold lodes have been made on the ridge south of the Apollo mine, in

the valley west of the Shumagin mine, and at points about 2 miles south of Coal Harbor.

Apollo Consolidated mine.—This mine was on a productive basis from 1891 to 1904 and was reopened during the summer of 1908, when 40 of the 60 stamps in the mill were put into operation and ore that had already been mined was run through the mill. The occurrence of gold ore at this locality has been described by Becker [1] and by Martin,[2] who visited it in 1904, gathering some additional data.

The deposit, according to Becker's description, is a reticulated vein or zone of fracture, in a country rock of andesite and dacite. The ores include free gold, pyrite, galena, zinc blende, copper pyrite, and native copper. The ore is free milling, a large part of the gold being carried in the native state. The chief gangue mineral is quartz, but calcite and orthoclase are present in subordinate amounts. The ore body strikes N. 20° E. It is from 5 to 40 feet wide and forms a chute that pitches northward. The chute comes to the surface at the south end of the workings at an elevation of 600 feet, and at the north end it narrows and becomes of low grade at a depth of about 800 feet. Several attempts have been made to reach the ore body at lower levels by shaft and tunnel, and long crosscut tunnels have been driven in prospecting the adjoining areas. In places the ore body was exceedingly rich, carrying up to $50 a ton; the average for the main ore body was perhaps about $8 a ton. The main chute has not been worked out. Some ore has been taken from minor zones of fracture in the crosscut tunnels, but ore has not been found in these zones in sufficient quantities to justify a continuation of the work. The country rock has been mineralized to a certain extent on either side of the main ore body.

Becker concluded that the country rock is Miocene or post-Miocene, because of its lithologic similarity to andesite, which is supposed to overlie the Miocene at the north end of the island. He would, accordingly, make the mineral veins of very recent Tertiary or post-Tertiary age. The present writer believes the post-Miocene andesites at the north end of Unga Island to be distinct in age from the country rock in which the gold ledges occur. The younger andesites cover a portion of the south end of the island and overlie irregularly the gold-bearing formation. The age of the rock in which the gold-bearing ledges occur is not definitely known, but it is believed by the writer to be Mesozoic or older.

Sitka mine.—This mine is located north of the Apollo mine across the valley. The ore body is associated with a sheer zone which strikes at right angles to the Apollo ore body. The rock in which

[1] Becker, G. F., Reconnaissance of the gold fields of southern Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 12, 83-85.

[2] Martin, G. C., Gold deposits of the Shumagin Islands: Bull. U. S. Geol. Survey No. 259, 1905, pp. 100-101.

this ore occurs is of the same general type as that at the Apollo mine; the ores consist of free gold, galena, zinc blende, and pyrite, and the chief gangue mineral is quartz, with subordinate amounts of calcite. The ore, however, is of low grade, and has never yet paid for the working. Some of the material in the dump was run through the mill during the summer of 1908. The superintendent believes that the ore could now be mined and milled at a profit. This mine is connected by a tramway with the Apollo plant, so that the ore may be handled at the Apollo mill.

Shumagin mine.—The Shumagin claims have been staked out along two ledges which strike N. 60° E. and outcrop in a low ridge one-half mile southwest of the head of Baranof Harbor. The southern ledge is about 50 feet thick, but the ore has not proved sufficiently rich to encourage mining. The other ledge, which varies in width from 2 to 3 feet, is reported to carry values commonly ranging between $4 and $5 to the ton, and nowhere running below $2. These quartz ledges are in shear zones, and are interrupted by many horses of country rock. The present workings consist of two tunnels, with crosscuts. The lower tunnel, which has been driven 363 feet, passes through the wider quartz ledge, and within a short distance of the second ledge. A crosscut 75 feet long has been made at the end of this tunnel. The upper tunnel is 79 feet long, and a crosscut at the end runs 116 feet to the east and 53 feet to the west along the ore body. The two tunnels are separated in elevation by 150 feet.

UNALASKA ISLAND.

The island of Unalaska is off the western extremity of Alaska Peninsula, near one of the most frequented routes from the Pacific Ocean to Bering Sea. It is important chiefly on account of its splendid natural harbor, on which are located two coaling and trade stations, Dutch Harbor and Unalaska. Several years ago an unsuccessful attempt was made to develop and mine some gold-bearing quartz veins near the village of Unalaska. A 3-stamp mill and a couple of tramways to connect the mill with the mines were erected, but these are now in a state of ruin. Quartz veins of economic value are reported by prospectors on several of the islands farther west.

The following notes are quoted from a report on this district, made in 1905 by Collier:[1]

The hard rocks of the islands are volcanic and consist of interbedded tuffs and flow that are cut by numerous dikes. The most common rocks are dark-gray andesites.[2]

South of Dutch Harbor for several miles the rocks are cut by a system of nearly vertical joint planes which extend approximately east and west. Mineralization

[1] Collier, A. J., Auriferous quartz veins on Unalaska Island: Bull. U. S. Geol. Survey No. 259, 1905, pp. 102-103.

[2] Emerson, B. K., Harriman Alaska Expedition, vol. 6, Geology, 1904, p. 29.

has occurred along these joints, and in some instances quartz veins have been formed. Several such quartz veins are exposed in the bluff west of Unalaska, where they have been prospected by short tunnels. The best example, however, is found at the gold mine located 1½ miles south of Unalaska and about a quarter of a mile from the shore of Captains Bay, where a number of small veins of this kind are contained in compact gray andesite. The largest of these forms the main ore body of the mine and has been opened for about 200 feet. It has a maximum width of 6 or 7 feet, but thins out in both directions from the widest part and at the ends of the tunnels is not over 1 or 2 feet wide. The samples obtained here consist of kaolin and cellular quartz, heavily stained with iron in the form of limonite. Samples obtained on the dump and around the mill indicate that a considerable portion of the ore originally contained unweathered pyrite and sulphide minerals. A sample taken by the writer from the face of the drift at the principal ore body was assayed by E. E. Burlingame & Co., of Denver, who reported 0.02 ounces of gold to the ton and a trace of silver. It is reported that before the mill was built assays promised very high values, which were not realized from the ore when milled.

GOLD PROSPECTS ON THE PENINSULA.

Locations for gold have been made at the head of Port Moller (Pl. VIII, p. 42) and on the shores of Mallard Duck Bay (Pl. VII, p. 40). The locations at the head of Port Moller are in basaltic lava, where the rock has been so altered as to present a brilliant yellow color. The exposure is strikingly conspicuous as far away as it can be seen. Most of the brilliantly colored rock had been staked out by the close of 1908, but no development work had been done. The samples taken by the writer proved to have a little gold in them.

The description[1] of the microscopical characters of this rock is given below:

Basalt.—This proves to be a highly porphyritic rock in which the phenocrysts form more than half the bulk of the section. There are numerous glassy labradorite phenocrysts and sporadic large augites embedded in a mesostasis consisting of granular augite, plagioclase microlites, and magnetite. The augite is altered and pseudomorphosed by a pleochroic reddish-yellow (iddingsite-like?) alteration product. This substance forms in the feldspar also to some extent. In one case it appears to have been derived from olivine.

The claims along the shores of Mallard Duck Bay are in mineralized crushed zones in an andesitic lava. These zones contain galenite, sphalerite, pyrite, and a large amount of quartz. The wall rock carries a noticeable amount of pyrite. The exposures seen in 1908 were scarcely below the surface soil. The most richly mineralized zone seen is on the southwest side of the bay near the head. This zone is from 4 to 6 feet wide and appears to have a linear extent of at least 100 feet. A mantle of glacial drift made it impossible to trace the zone farther without doing some prospecting work.

[1] Prepared by Adolph Knopf.

COPPER.

No copper mines have been opened up in southwestern Alaska, but several locations have been made for copper at Prospect Bay and on the east shore of Balboa Bay.

PROSPECT BAY.

Prospect Bay is a few miles west of Chignik Bay, on the south shore of Alaska Peninsula. (See Pl. VII, p. 40.) The copper property here has attracted some attention, and various reports regarding it have appeared in Alaskan and Pacific coast papers. The ore body is located at the west shore near the head of Prospect Bay, and fortunately near an excellent little harbor behind a sand and gravel hook. (Fig. 18.) The zone that has been staked is about 50 feet wide. It is a crushed zone, and in the fissures the minerals, which include pyrite, galena, sphalerite, chalcopyrite, and quartz, are in the crystalline form, the crystalline development being in places of the geode type. When these claims were visited during the early part of the 1908 season no large body of high grade ore had been developed, as was currently reported. Hand specimens fairly rich in copper minerals may be procured from the fracture cavities.

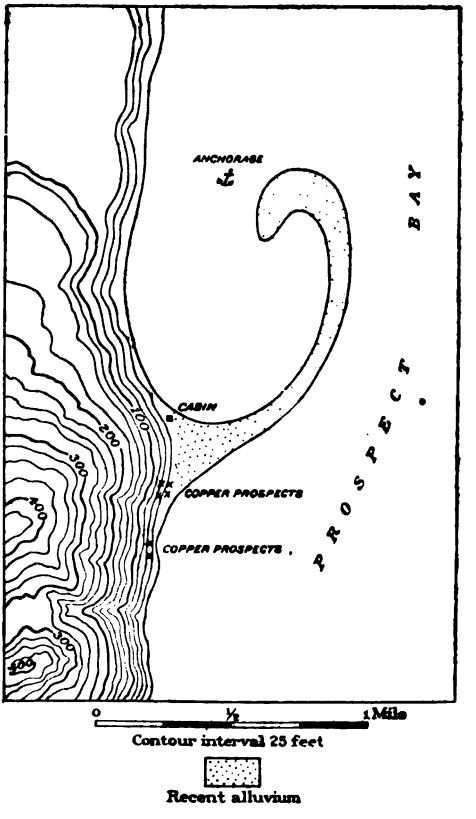


FIGURE 18.—Sketch map of a portion of Prospect Bay, showing the form of the harbor and the location of copper prospects.

BALBOA BAY.

Some copper occurs in a shear zone on the east shore of Balboa Bay, in the midst of the andesitic lava. There are several prospects in this vicinity, and one short tunnel was driven some years ago, but the claims have now been entirely abandoned.

SUGGESTIONS TO PROSPECTORS.

The period of active prospecting on the peninsula will probably be limited during most years to the months of June, July, August, and September. The heavy winter snowfall remains nearly to sea level until late in May or early in June, and since fresh snows of the succeeding winter begin to accumulate by the early part of September, by the close of that month little surface work could profitably be done. The period of prospecting on the islands would be somewhat longer than on the mainland.

The formations are excellently exposed along the Pacific coast and through the central part of the peninsula on the flanks of the mountains and on the canyon walls. The Pacific coast may, when proper care and patience are exercised, be visited in small boats, and from the heads of bays the central portion of the peninsula is at many places easily accessible. The Bristol Bay side of the peninsula will prove less attractive to prospectors, for the neighboring waters are exceedingly shallow and the area adjoining the coast is a tundra covered lowland. Boats may move readily into the central portion of the peninsula at Port Moller and at Port Heiden. Small boats may be taken up the rivers to the large lakes in the northwestern portion of the peninsula. Prospecting could probably be easily conducted from the shores of these lakes.

The formation known to contain workable coal is of Upper Cretaceous age, and has been described as the Chignik formation. This formation, which is found near the head of Herendeen Bay, northwest of Chignik Bay, and at Douglas village, near the northeastern extremity of the peninsula, is probably much more extensive than is now positively known. It is somewhat safe to infer that it extends northeastward from Chignik Bay for many miles, and as coal has been reported on the northwest slope of the Aleutian Range east of Chignik Lake, it is quite possible that the main coal-bearing formation may outcrop on that side of the peninsula. The structure is anticlinal, and consequently the Chignik formation may be expected near the northwest base of the range. It may also be found in the territory between Chignik Bay and Port Moller, though in this region Tertiary sediments and Recent volcanic rocks may mantle or obscure the formation. The Douglas locality of the Chignik formation is not known to contain coal.

The formation which overlies the Chignik is of Eocene age, and is known as the Kenai formation. It contains seams of lignite, which have in places been worked for local markets. Reference to Plate VI (in pocket) will show that this formation is very extensive, and it is probably much more extensive than is yet known. At no place in the peninsula, however, has coal been found in the Kenai formation of such quality as to encourage expensive development work or

any large investment. The coal reported west of Herendeen Bay on the northwest side of the peninsula is probably of Kenai (Eocene) age.

The gold veins which have been profitably worked in this portion of Alaska occur in andesitic rocks believed to be of early Tertiary age. No metalliferous ores have been found in or in association with the sedimentary rocks or recent volcanics in the peninsula. The known extent of these andesitic rocks is shown on Plates VII (p. 40) and VIII (p. 42), but they will doubtless be found to be much more extensive. They have commonly been so altered by metamorphic processes that they may be detected by their brilliant red and yellow colors. The gold-bearing quartz veins which have been thus far located are not in the most highly colored portions of this group of rocks, but the colors may guide the prospector in the unsurveyed portions of the field to areas where time may be more profitably spent. The rock bearing the quartz veins is commonly rich in pyrite, and the weathering of this mineral accounts in part for the brilliant colors referred to.

The single instance of placer gold on the shore of Popof Island occurs on the beach near certain of the older Popof lavas, where the waves have broken and worked the gold-bearing rock of the island to a beach gravel. Locations for gold have been made at the head of Port Moller, but samples taken from that locality have not shown large values. Near the head of Mallard Duck Bay, an arm of Chignik Lagoon, the andesitic lavas, which might profitably be prospected, outcrop, and there are indications of mineralization in certain of the shear zones near the beach. All the gold-bearing quartz lodes that have been profitably worked occur in association with crushed zones. The minerals occurring in association with gold are galenite, sphalerite, pyrite, and quartz. Prospecting should, therefore, be most actively prosecuted in the areas indicated on the maps (Pls. VII and VIII) accompanying this report as containing "andesites with associated tuffs and breccias," and in the extension of such areas in the unsurveyed portions of the peninsula and the neighboring islands.

The copper which has been located on the peninsula occurs in association with a shear zone in andesitic lava. Though detailed work has not been done around Prospect Bay where these copper locations have been made, yet it is believed that the rocks there belong to the same group in which the gold-bearing lodes have been found. It is not unlikely that a zone or belt of these earlier Tertiary lavas and volcanic rocks border the coast from Prospect Bay westward to the vicinity of Stepovak Bay, and that belt might profitably be prospected for gold and copper.

Suggestions bearing on the petroleum in the peninsula and the prospecting for other oil fields have been made on page 124.

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

BULLETIN 468

RESULTS OF SPIRIT LEVELING IN TEXAS

1896 TO 1910, INCLUSIVE

R. B. MARSHALL, CHIEF GEOGRAPHER

WORK DONE IN COOPERATION WITH THE STATE OF TEXAS
DURING 1902, 1903, 1909, AND 1910

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

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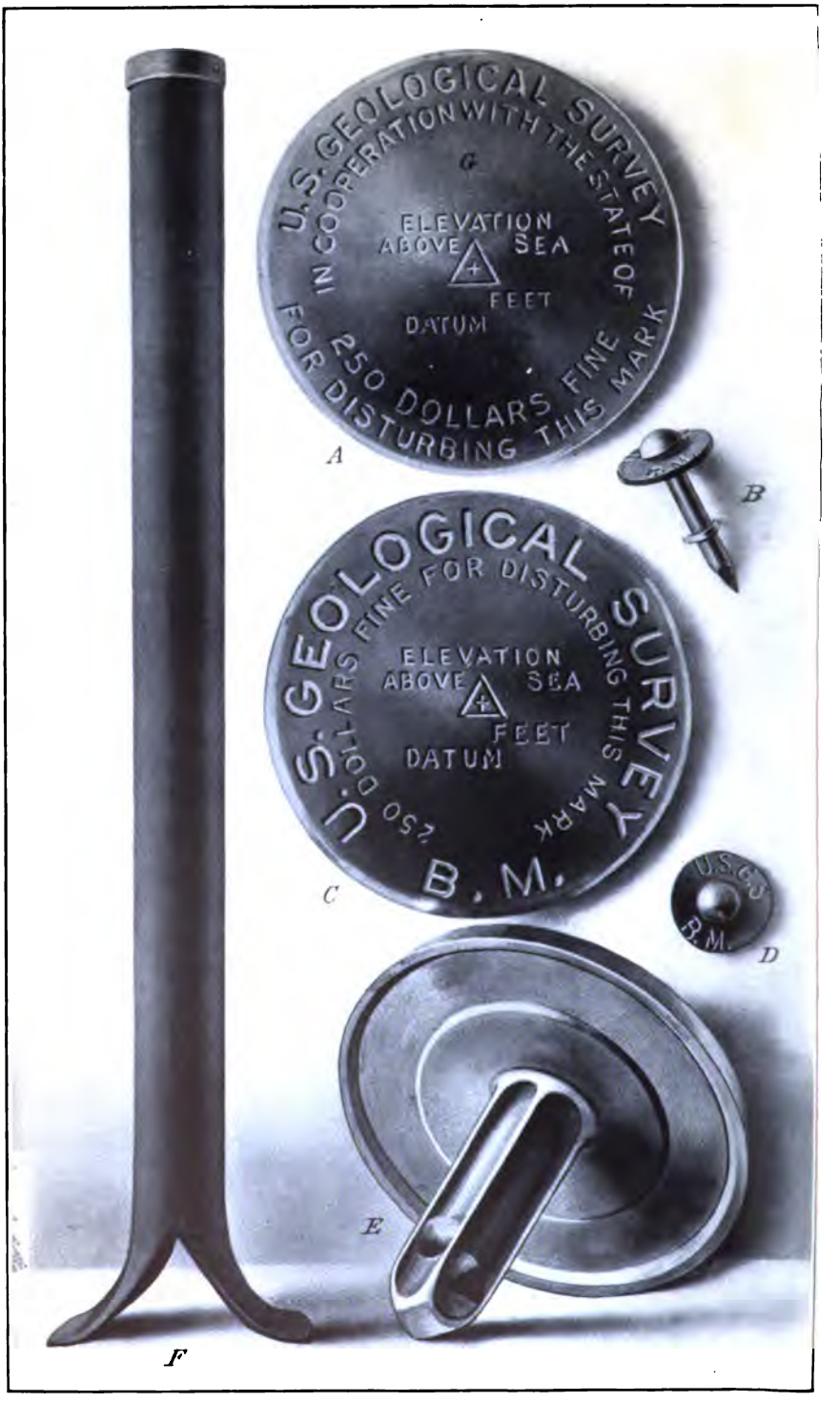

GEOLOGICAL SURVEY BENCH MARKS.

A, Tablet used in cooperating States. The State name is inserted at *G*.
B and *D*, Copper temporary bench mark, consisting of a nail and copper washer.
A, *C*, and *E*, Tablets for stone or concrete structures.
F, Iron post used where there is no rock.

RESULTS OF SPIRIT LEVELING IN TEXAS, 1896 TO 1910, INCLUSIVE.

R. B. MARSHALL, Chief Geographer.

INTRODUCTION.

Scope of the work.—All results of spirit leveling in Texas previously published by the United States Geological Survey and all the results of later work are included in this report, rearranged by quadrangles. Elevations are based on heights of bench marks along precise-level lines of the Coast and Geodetic Survey as adjusted in 1907, and on the precise-level line of the United States Geological Survey from the Texas-New Mexico boundary line to El Paso. The elevations of certain bench marks in Brewster, El Paso, and Presidio Counties are based on railroad datum, as noted in the separate headings, and are, therefore, only approximate.

Personnel.—The field work from 1896 to 1906, inclusive, was done under E. M. Douglas, geographer, and the later work under E. C. Barnard, geographer, under the general direction of R. B. Marshall, chief geographer. The names of the various levelmen are given in the introduction to each list. The office work of computation, adjustment, and preparation of lists was done mainly by S. S. Gannett, geographer, and D. H. Baldwin, topographer, and since 1907 under the general direction of E. M. Douglas, geographer.

Classification.—The elevations are classified as precise or primary, according to the methods employed in their determination. For precise-level lines instruments and rods of the highest grade are used, each line is run both forward and backward, and every precaution is taken to guard against error. The allowable divergence between the forward and the backward lines in feet is represented by the formula $0.017\sqrt{D}$, in which D is the distance in miles between bench marks. For primary lines standard Y levels are used; lines are run in circuits or are closed on precise lines, with an allowable closing error in feet represented by $0.05\sqrt{D}$, in which D is the length of the circuit in miles, sufficient care being given to the work to maintain this standard. For levels of both classes careful office adjustments are made, the small outstanding errors being distributed over the lines.

Bench marks.—The standard bench marks are of two forms. The first form is a circular bronze or aluminum tablet (*C* and *E*, Pl. I), 3½ inches in diameter and one-quarter inch thick, having a 3-inch stem, which is cemented in a drill hole in solid rock in the wall of some public building, a bridge abutment, or other substantial masonry structure. The second form (*F*, Pl. I), used where masonry or rock is not available, consists of a hollow wrought-iron post 3½ inches in outer diameter and 4 feet in length. The bottom is spread out to a width of 10 inches in order to give a firm bearing on the earth. A bronze or aluminum-bronze cap is riveted over the top of the post, which is set about 3 feet in the ground. A third style of bench mark with abbreviated lettering (*B* and *D*, Pl. I), is used for unimportant points. This consists of a special copper nail 1½ inches in length driven through a copper washer seven-eighths inch in diameter. The tablets, as well as the caps on the iron posts, are appropriately lettered, and cooperation by States is indicated by the addition of the State name (*G*, Pl. I).

The numbers stamped on the bench marks described in the following pages represent the elevations to the nearest foot as determined by the levelman. These numbers are stamped with $\frac{3}{16}$-inch steel dies on the tablets or post caps to the left of the word "feet." The office adjustment of the notes and the reduction to mean sea level datum may so change some of the figures that the original markings are 1 or 2 feet in error. It is assumed that engineers and others who have occasion to use the bench-mark elevations will apply to the Director of the United States Geological Survey, at Washington, D. C., for the adjusted values and will use the markings as identification numbers only.

Datum.—All United States Geological Survey elevations are referred to mean sea level, which is the level that the sea would assume if the influence of winds and tides were eliminated. This level is not the elevation determined from the mean of the highest and the lowest tides, nor is it the half sum of the mean of all the high tides and the mean of all the low tides, which is called the half-tide level. *Mean sea level is the average height of the water, all stages of the tide being considered.* It is determined from observations made by means of tidal gages placed at stations where local conditions, such as long, narrow bays, rivers, and like features will not affect the height of the water. To obtain even approximately correct results, these observations must extend over at least one lunar month, and if accuracy is desired they must extend over several years. At ocean stations the half-tide level and mean sea level usually differ but little. It is assumed that there is no difference between the mean sea level as determined from observations in the Atlantic Ocean, the Gulf of Mexico, or the Pacific Ocean.

The connection with tidal stations for bench marks in certain areas that lie at some distance from the seacoast is still uncertain, and this fact is indicated by the addition of a letter or word to the right of the word "Datum" on tablets or posts. For such areas corrections for published results will be made from time to time as the precise-level lines of the United States Geological Survey or other Government organizations are extended.

Topographic maps.—Maps of the following quadrangles wholly or partly in Texas have been published by the United States Geological Survey up to May 1, 1911. They may be obtained, except as noted, for 5 cents each or $3 a hundred, on application to the Director of the Survey at Washington, D. C.:

Abilene.
Albany.
Alpine.
Anson.
Atlanta (Tex.-Ark.-La.).
Austin.
Ballinger.
Bastrop.
Blanco.
Brackett.
Brady.
Breckenridge.
Brownwood.
Burnet.
Cerro Alto.
Chisos Mountains (double sheet, 10 cents).
Chispa.
Cleburne.
Coleman.
Dallas.
Denison (Tex.-Okla.).
Eagle Mountain.
Eastland.
Eden.
El Paso.
Flatonia.
Fort Davis.
Fort Hancock.
Fort McKavett.
Fort Worth.
Fredericksburg.
Gainesville (Tex.-Okla.).
Gatesville.
Georgetown.
Granbury.
Hamilton.
Hayrick.
Kerrville.
Lampasas.
Linden.
Llano.
Marfa.
Mason.
Meridian.
Montague (Tex.-Okla.).
New Boston.
Nueces.
Palo Pinto.
Polvo.
Rio Grande.
Roby.
Rock Springs.
Ruidosa.
Salt Basin.
San Angelo.
San Antonio (double sheet, 10 cents).
San Carlos.
San Saba.
Shafter.
Sherwood.
Sierra Blanca.
Stephenville.
Sweetwater.
Taylor.
Temple.
Terlingua.
Terlingua special.
Texarkana (Tex.-Ark.).
Texas contour map (15 cents).
Uvalde.
Valentine.
Van Horn.
Waco.
Weatherford.

PRECISE LEVELING.

Courchesne and El Paso Quadrangles.

EL PASO COUNTY.

The following are the unadjusted results for the Texas portion of a precise level line run in 1905 by M. S. Bright along the Atchison, Topeka & Santa Fe Ry., from Albuquerque, N. M., to El Paso, Tex. The elevations accord with an elevation at Rincon determined by precise leveling from Yuma.

COURCHESNE QUADRANGLE.

La Tuna south along Atchison, Topeka & Santa Fe Ry. to El Paso.

	Feet.
Vinton, 21 feet east of main line under Vinton signboard; iron post stamped "3774"	3,785.773
Canutillo, 80 feet east of main track, at southwest corner of J. J. Cumflid's house; iron post stamped "350-B-1905"	3,763.541
Montoya, in front of signboard, top of rail	3,753.41
Montoya, 1.5 mile south of, 40 feet west of road crossing, 5 feet east of fence corner; iron post stamped "354-B-1905"	3,749.837
Whites spur, top of rail	3,746.096
Whites spur, 2.8 miles south of, 0.25 mile north of milepost 1150, 50 feet east of track, 16 feet east of public road; iron post stamped "357-B-1905"	3,738.892
Whites spur, 5.25 miles south of, 240 feet north of public road crossing, 100 feet east of river, 45 feet east of track, 12 feet east of wagon road; iron post stamped "359-B-1905"	3,732.126
International boundary line monument 1; top of masonry at northeast corner (Boundary Commission elevation, 3,713.6)	3,725.166

EL PASO QUADRANGLE.

Union Station via City Hall to El Paso County courthouse and return to Union Station.

El Paso, Atchison, Topeka & Santa Fe Ry. station, in front of; top of rail	3,708.45
El Paso, city hall, in west end of lower stone step at north entrance; aluminum tablet stamped "3698" (C. & G. S. unadjusted elevation, 1911, 3711.731 feet)	3,709.607
El Paso, city hall, in east end of steps at south entrance, in cement; aluminum tablet stamped "365-B-1905" (C. & G. S. unadjusted elevation, 1911, 3710.699 feet)	3,708.581
El Paso County courthouse, in west end of lower step at south entrance; aluminum tablet stamped "366-B-1905" (C. & G. S. unadjusted elevations, 1911, 3711.359 feet)	3,708.706
El Paso County courthouse, on top of pyramid stone at west side of north entrance; cross (city bench mark)	3,710.086
El Paso, in front of Southern Pacific R. R. station; top of rail	3,724.03
El Paso, in front of Union station; top of rail	3,724.07

PRIMARY LEVELING.

Atlanta, Jefferson, Linden, New Boston, and Texarkana Quadrangles.

BOWIE, CASS, AND MARION COUNTIES.

The elevations in these lists are based on elevations of the Coast and Geodetic Survey precise level line along Missouri, Kansas & Texas Railway at Jefferson and Pittsburg.

The leveling was done by Chester Irvine in 1905.

JEFFERSON QUADRANGLE.

Jefferson via Texas & Pacific Ry. northeast to Bivins.

	Feet.
Jefferson, opposite Missouri, Kansas & Texas Ry. station, 16 feet north of track, 7 feet north of telegraph pole, in top of limestone post 6 by 6 inches on top; bottom of square hole	189.488
Jefferson, 2.7 miles north of, 300 feet east of Rowe's house, 20 feet west of track, in southwest corner of right of way fence at road crossing; iron post stamped "190 ADJ 1903"	189.920
Jefferson, 6.5 miles north of, west of track, at corner of right of way fence at road crossing; iron post stamped "295 ADJ 1903"	295.307
Lodi, in front of station; top of rail	247.7
Lodi, 100 feet south of station, 40 feet east of track, at corner of right of way fence; iron post stamped "253 ADJ 1903"	253.298
Lodi, 3 miles north of, 40 feet west of spur to lumber shed, 500 feet northwest of milepost 39; iron post stamped "231 ADJ 1903"	231.317
Kildare, in front of station; top of rail	285.32
Kildare, 1 mile north of, 600 feet north of milepost 36, 40 feet west of track, at road crossing; iron post stamped "252 ADJ 1903"	252.158
Wayne water tank, 0.5 mile north of, 350 feet north of Lynch's house, 40 feet each of track at road crossing; iron post stamped "268 ADJ 1903"	268.148

Linden southeast along road to Kildare.

Linden, 3.5 miles southeast of, 10 feet north of road, at forks, south end of lane at fence corner; iron post stamped "358 ADJ 1903"	358.768
Kildare, 2.5 miles northwest of, 700 feet north of crossroads, on small summit 10 feet east of road; iron post stamped "342 ADJ 1903"	342.746

ATLANTA QUADRANGLE.

Bivins north along Texas & Pacific Ry. to Alamo Mills.

Bivins, 30 feet north of track, 200 feet northeast of station; iron post stamped "313 ADJ 1903 Prim. Trav. Sta. No. 25"	313.330
Bivins, in front of station; top of rail	314.0
Atlanta, 3 miles south of, 50 feet east of track, 20 feet east of first telegraph pole north of milepost 27; iron post stamped "279 ADJ 1903"	279.448
Atlanta, 0.2 mile south of station, 120 feet south of milepost 24, 40 feet east of road crossing, in corner of right of way fence; iron post stamped "256 ADJ 1903"	256.301

	Feet.
Queen City, 100 feet north of water tank, 40 feet east of track at road crossing, in corner of right of way fence; iron post stamped "Prim. Trav. Sta. No. 65 334 ADJ 1903"	334.141
Queen City, in front of station; top of rail	346.1
Lanark, 150 feet north of station signboard, 40 feet east of track, at road crossing; iron post stamped "338 ADJ 1903"	338.172
Springdale, 30 feet west of station signboard, 10 feet north of track; iron post stamped "244 ADJ 1903"	244.488
Alamo, 900 feet north of station signboard, 50 feet west of track at road crossing, in corner of right of way fence; iron post stamped "Prim. Trav. Sta. No. 107 243 ADJ 1903"	243.082

Atlanta east along Texas, Arkansas & Louisiana Ry. to Bloomburg, thence south along Kansas City Southern Ry. to State line near Ravana, Ark.

Atlanta, 0.2 mile south of, 120 feet south of milepost 24, 40 feet east of road crossing, in corner of right of way fence; iron post stamped "256 ADJ 1903"	256.301
Atlanta, in front of station; top of rail	260.6
Atlanta, 3.9 miles northeast of, north of track at road crossing; iron post stamped "349 ADJ 1903"	349.243
Bloomburg, 350 feet west of station, 20 feet south of track, at road crossing; iron post stamped "310 ADJ 1903"	309.921
Bloomburg, in front of station; top of rail	307.
Bloomburg, 2.5 miles south of, 40 feet east of track, on State line; iron post stamped "261 ADJ 1903"	261.554

Atlanta northwest along road 3.4 miles.

Atlanta, 3.4 miles northwest of, 400 feet west of cabin, 15 feet north of road, at edge of large basin; iron post stamped "330 ADJ 1903"	329.799

TEXARKANA QUADRANGLE.

Alamo Mills north along Texas & Pacific Ry. to Texarkana.

Sulphur, 1,900 feet south of station, 40 feet west of track at road crossing, in corner of right of way fence; iron post stamped "232 ADJ 1903"	232.474
Sulphur, opposite station; top of rail	237.9
Sulphur, 2.5 miles north of, 40 feet west of track, 30 feet south of milepost 5, south of gate at road crossing; iron post stamped "288 ADJ 1903"	288.262
Texarkana, 2.9 miles south of, 600 feet north of milepost 3, south of road, 50 feet east of track; iron post stamped "274 ADJ 1903"	274.006
Texarkana, in front of Kansas City Southern Ry. station; top of rail	290.03
Texarkana post office, in stone railing south front west of steps, 5 feet above sidewalk; bronze tablet stamped "332 ADJ 1903"	331.896
Texarkana, Miller County (Ark.) courthouse, at northeast corner of yard, United States Geological Survey meridian mark; bronze tablet stamped "337 ADJ 1903 1905 TEXARKANA"	337.447

Texarkana southwest along tracks of St. Louis & Southwestern Ry. Co. of Texas to Redwater.

	Feet.
Eylau, 1.5 miles southeast of station, in fence corner northwest of road crossing; iron past stamped "341 ADJ 1903"	341.464
Rowans spur, 100 feet east of station signboard, south of track; iron post stamped "287 ADJ 1903"	286.702
Redwater, 2.9 miles east, Beesley road crossing, 30 feet east of track, in fence corner; iron post stamped "260 ADJ 1903"	260.470

Texarkana west along Texas & Pacific Ry. to Leary.

Argo, 1,000 feet west of signboard, 200 feet east of west end of siding, south of track; iron post stamped "294 ADJ 1903"	293.857
Park, in front of station; top of rail	352.3
Park, 200 feet east of station, north of track; iron post stamped "349 ADJ 1903"	349.419
Park, 2 miles west of, 340 feet east of milepost 7, 40 feet north of track; iron post stamped "Prim. Trav. Sta. No. 23 346 ADJ 1903"	346.507
Leary, 150 feet northeast of signboard post, north of track; iron post stamped "379 ADJ 1903"	379.084

Texarkana north along Kansas City Southern Ry. to Whatley.

Ghio Park, 25 feet southwest of main entrance of park, at street car crossing; iron post stamped "348 ADJ 1903"	348.071
Whatley, in front of station; top of rail	306.3
Whatley, north end of siding, 40 feet east of track, near fourth telegraph pole north of milepost 482; iron post stamped "300 ADJ 1903"	300.146

NEW BOSTON QUADRANGLE.

Redwater southwest along track of St. Louis Southwestern Ry. Co. of Texas to Point near Bassett.

Redwater, in fence corner 200 feet east of station, 40 feet north of road crossing; iron post stamped "294 ADJ 1903"	294.041
Redwater, in front of station; top of rail	291.5
Clem Sawmill spur, at corner fence 40 feet southeast of road crossing; iron post stamped "250 ADJ 1903"	249.881
Maud, in front of station; top of rail	289.10
Maud, 150 feet northwest of station, north of track near large oak tree; iron post stamped "289 ADJ 1903"	288.610
Corley, in front of station; top of rail	300.4
Corley, 0.5 mile west of, in fence corner 100 feet northeast of road crossing; iron post stamped "290 ADJ 1903"	289.721
Fowk siding, 0.5 mile east of, west of track at road crossing at Ashburn's house; iron post stamped "270 ADJ 1903"	270.210

Leary west along Texas & Pacific Ry. to New Boston, thence southwest along road to Simms.

Hooks, in front of station; top of rail	374.6
Hooks, 75 feet west of station, north of track and east of road crossing; iron post stamped "Prim. Trav. Sta. No. 52 376 ADJ 1903"	376.514
Whaley, in front of station; top of rail	360.8

	Feet.
Whaley, 10 feet northeast of signboard, 30 feet west of gate; iron post stamped "363 ADJ 1903"	362.850
New Boston, 2 miles east of, 100 feet east of milepost 20, south of track at road crossing; iron post stamped "357 ADJ 1903"	357.601
New Boston, in front of station; top of rail	353.7
New Boston, 0.5 mile west of station, north of track and east of road crossing, in fence corner; iron post stamped "367 ADJ 1903"	366.774
New Boston, 3 miles southwest of, north of Mitchell house, at junction of New Boston and DeKalb roads; iron post stamped "341 ADJ 1903"	340.914
New Boston, 6.5 miles southwest of, south of road on north bank of Anderson Creek, 30 feet west of Thompson's mailbox; iron post stamped "286 ADJ 1903"	286.284

LINDEN QUADRANGLE.

Point 3.4 miles northwest of Atlanta west along road via Douglassville to Cusseta.

Atlanta, 7.5 miles northwest of, 15 feet south of road at summit, 100 feet north of cabin; iron post stamped "420 ADJ 1903"	419.882
Douglassville, 3 miles east of, 12 feet south of road, 200 feet southwest of large white house; iron post stamped "408 ADJ 1903"	408.081
Douglassville, 100 feet northeast of Baptist Church, south of road at fence corner; iron post stamped "385 ADJ 1903"	385.053
Douglassville, 3.5 miles west of, 30 feet south of road forks, at corner of fence at cabin; iron post stamped "303 ADJ 1903"	303.493

Cusseta southeast along road to Linden.

Cusseta, at forks of road 100 feet southwest of Fulcher store; iron post stamped "485 ADJ 1903"	485.490
Cusseta, 2.8 miles south of, 20 feet west of road, 20 feet west of house; iron post stamped "385 ADJ 1903"	385.639
Cusseta, 4 miles south of, 3 feet northeast of crossroads; iron post stamped "Prim. Trav. Sta. No. 341 400 ADJ 1903"	400.311
Cusseta, 6 miles southeast of, signboard "Linden 6½ miles" at crossroads; iron post stamped "402 ADJ 1903"	402.691
Linden, 3 miles northwest of, 10 feet west of road, 80 feet south of road forks, 500 feet north of old gin; iron post stamped "467 ADJ 1903"	467.561
Linden, at northeast corner of Cass County courthouse yard; iron post stamped "379 ADJ 1903 Prim. Trav. Sta."	379.246
Linden, 0.5 mile southeast of, 20 feet southwest of road forks, at end of lane; iron post stamped "367 ADJ 1903"	367.220

Roach southwest along road to Linden.

Linden, 5 miles northeast of, 200 feet south of road, at north front of New Colony Church; iron post stamped "306"	306.079
Linden, 3 miles northeast of, 10 feet north of road at summit, 300 feet east of cabin; iron post stamped "371 ADJ 1903"	371.154

Atlanta southwest along road to Roach.

Roach, 40 feet southeast of road forks; iron post stamped "308 ADJ 1903"	308.176

Linden west along road to point near Milne, thence north to point 5 miles southeast of Cusseta on Cusseta-Linden road.

	Feet.
Linden, 4.8 miles west of, 10 feet south of road and east of basin; iron post stamped "320 ADJ 1903"	320.111
Jaybart, 1.2 miles east of, 300 feet south of Griffiths farmhouse, at forks of road; iron post stamped "310 ADJ 1903"	310.070
Jaybart, 2 miles north of, 40 feet southeast of road forks; iron post stamped "300 ADJ 1903"	300.377
Almira, 150 feet west of post office, southwest of forks of road; iron post stamped "357 ADJ 1903"	358.052

Bassett, Bogata, Boxelder, Daingerfield, Hughes Springs, Mount Pleasant, and Shawneetown Quadrangles.

BOWIE, CASS, RED RIVER, AND TITUS COUNTIES.

The elevations in the following list are based on the Coast and Geodetic Survey precise level line along the Missouri, Kansas & Texas Ry.

The leveling was done by W. A. Gelbach, in 1908, with the exception of a line along the St. Louis Southwestern Railway Co. of Texas tracks, run by Chester Irvine in 1905.

BASSETT QUADRANGLE.

Simms southwest along track of St. Louis Southwestern Ry. of Texas to Bridge 103.

	Feet.
Simms, in front of station; top of rail	276.3
Sims, 1,000 feet west of signboard, 60 feet south of west end of siding; iron post stamped "275 ADJ 1903"	274.940
Bassett, 60 feet east of station, 20 feet south of track, 20 feet west of pump house; iron post stamped "249 ADJ 1903"	249.306
Finley, 0.5 mile east of, sixth telegraph pole east of milepost 454, in corner of right of way fence, 40 feet southeast of road crossing; iron post stamped "261 ADJ 1903"	261.419
Finley, in front of station signboard; top of rail	259.4
Naples, 4.5 miles east of, 40 feet south of track, 150 feet west of Bridge 103; iron post stamped "259 ADJ 1903"	259.519

Simms north along highway to Malta.

Simms, 100 feet southeast of Simms's house, north of road near telegraph pole; iron post stamped "352 ADJ 1903"	352.559
Simms, 0.5 mile west of, signboard "Bassett 4 M," T road east, head of spike in root on north side of tree	338.50
Simms, 2.2 miles northwest of, on Malta road, northeast corner of crossroads; head of spike in root of tree	360.84
Simms, 2.8 miles north of, on Malta road, in front of T road north, 400 feet west of John Harris's house; iron post stamped "Prim. Trav. Sta. No. 94, 352 1908"	352.349
Anderson Creek bridge, 0.3 mile north of, northeast corner of T road east; head of spike in root on south side of tree	284.83

	Feet.
Anderson Creek bridge, 1.3 miles north of, 100 feet north of bridge over small stream, east of road at road fork west; iron post stamped "306 1908"	306.269
De Kalb, 9 miles southeast of T road east; spike in root of tree with signboard	350.74
Malta, 2 miles south of, west of Simms road at junction of New Boston-De Kalb road, 50 feet west of small creek, in top of small knoll; iron post stamped "371 1908"	371.279
Malta, 1.3 miles south of, at crossroads; head of spike in root of tree	365.77
Malta, 50 feet north of Texas & Pacific Ry. track, at crossing in front of Norman's store, corner of right of way fence; iron post stamped "Prim. Trav. Sta. No. 103, 409 1908"	409.113

De Kalb southwest along highway to Lydia.

De Kalb, 0.8 mile south of, at road fork west; head of spike in root of tree	370.63
De Kalb, 2.1 miles south of, east of road at fork of roads to Dalby Springs and Lydia, in top of hill south of Anderson Creek; iron post stamped "375 1908"	374.947
De Kalb, 4 miles southwest of, on Lydia road, 700 feet east of N. Lawrence's house, 55 feet west of mail box 76, south of road on top of mound; iron post stamped "416 1908"	415.917
Lydia, 3.5 miles northeast of, on De Kalb road, 60 feet east of signboard "De Kalb 7 miles," 200 feet west of small creek, south of road, in top of knoll; iron post stamped "392 1908"	392.060

Lydia southeast along highway to Bassett, thence west to Finley.

Lydia, 3 miles southeast of, on Dalby Springs road, 0.4 mile north of signboard "Dalby Springs 4 miles," northeast corner of crossroads, signboard "De Kalb 8 miles"; iron post stamped "360 1908"	360.159
Dalby Springs, 0.9 mile north of, 60 feet south of T road west leading to Lydia, east of road; iron post stamped "341 1908"	341.414
Dalby Springs, 100 feet south of bridge; head of spike in root on north side of large white oak tree	308.15
Dalby Springs, 0.5 mile east of; head of spike in root of tree at northeast corner of T road north	326.43
Dalby Springs, 3 miles east of, on Bassett road, 1 mile north of Pinkham, 500 feet northeast of Christopher Black's house, at crossroads, near mail-box post; iron post stamped "332 1908"	332.160
Pinkham, 1 mile south of, east of road opposite empty house, 40 feet south of fork in road; iron post stamped "276 1908"	275.641
Bassett, 1.8 miles north of, on Dalby Springs road, east of road opposite corner of field, 700 feet north of empty house; iron post stamped "278 1908"	278.227
Bassett, iron railway water tank, northwest side of, 4 feet west of bottom of iron ladder on tank, 2 inches below bottom of tank, notch cut in slope of concrete foundation	251.77
Finley, 0.5 mile east of, at railway crossing, southwest corner of, in corner of right-of-way fence, 6 feet west of byroad, 11 feet north of south line of right of way, projecting about 1 inch above ground; iron post stamped "261 ADJ 1903"	261.419

DAINGERFIELD QUADRANGLE.

Bridge 103 southwest along track of St. Louis Southwestern Ry. Co. of Texas to Omaha.

	Feet.
Naples, 1.1 miles east of, 120 feet east of bridge 120, 40 feet southwest of road crossing at west end of cut; iron post stamped "320 ADJ 1903"	319.874
Naples, in front of station; top of rail	403.5
Naples, 1,500 feet west of station, 40 feet north of track, at corner of right of way fence at road crossing; iron post stamped "402 ADJ 1903"	402.410
Omaha, 60 feet west of station, 40 feet north of track; iron post stamped "406 ADJ 1903"	409.168

Naples southeast along highway to Cusseta.

Naples, 4 miles east of, on Marietta road, 500 feet north of Dr. J. Davis's house, south of road, 40 feet west of "Naples 4 miles" post; iron post stamped "388 1908"	387.581
Dalton, road fork by cotton gin and sawmill; head of spike in base of white oak tree	300.10
Dalton, 0.3 mile east of, fork of Bryan's mill and Marietta roads; head of spike in root of tree	341.41
Marietta, 3 miles northwest of, on Naples road, 300 feet east of Hampton's house, southeast corner of crossroads; iron post stamped "361 1908"	361.171
Marietta, west edge of, north of road, 200 feet west of blacksmith shop; iron post stamped "356 1908"	356.099
Cusseta, 3.5 miles west of, crossroads top of hill in front of white house, spike in root of tree	387.97

Point near Cusseta southwest and south along highway to Jaybart.

Flat Creek Church, 180 feet southeast of, in fork of road; iron post stamped "365 1908"	365.325
Levi Milner's house (formerly Jaybart post office), 0.5 mile south of, at road fork; head of spike in top of stump	350.98
Sardis, 4.4 miles northeast of, 1 mile south of Levi Milner's house (formerly Jaybart post office), at fork of road, 0.5 mile northeast of sawmill; iron post stamped "343 1908"	343.304

Jaybart southwest along highway to Sardis.

Sardis Church, 180 feet northwest of, in fork of road; iron post stamped "Prim. Trav. Sta. No. 4, 309 1908"	309.564

Daingerfield north along highway to Omaha.

Daingerfield, in west side of county courthouse, in center of fourth brick from northwest corner of building, about 4 feet from ground and midway between window and northwest corner; copper bolt (Coast and Geodetic Survey bench mark A-3)	402.852
Rocky Branch, 2 miles south of, 4 miles north of Daingerfield, top of hill south of cotton gin, at fork of road to west; head of spike in root of tree	409.54
Rocky Branch, 1.7 miles south of, 4.5 miles north of Daingerfield, east of road opposite J. R. Old's house; iron post stamped "430 1908"	429.699

	Feet.
Omaha, 4 miles south of, 0.3 mile north of signboard "Omaha 4 miles," east of road, in forks of road; iron post stamped "Prim. Trav. Sta. No. 3, 1908, 385"	385.514
Omaha, 2.5 miles south of, in fork of road in front of small schoolhouse; head of spike in root of tree	363.91
Omaha, 0.5 mile south of, T road north; head of spike in root of tree	386.26

HUGHES SPRINGS QUADRANGLE.

Sardis southwest to Hughes Springs.

	Feet.
Sardis, 1.9 miles west of, on Hughes Springs road, northeast corner of T road north; iron post stamped "330 1908"	330.084
Hughes Springs, 3.8 miles east of, on Sardis road, south of road at T road north to Linden, foot of mail box 98, head of spike in root of tree	357.57
Wilson siding, 1.5 miles south of Hughes Springs, on Missouri, Kansas & Texas Ry.; top of rail in front of signboard	326.0
Hughes Springs, in west face of brick building owned by T. B. Keaster, in new part of building, in double column where old and new buildings join, 11 paces from northwest corner of building, in twenty-first tier of brick above concrete sidewalk; copper bolt (Coast and Geodetic Survey bench mark B-3)	378.26

SHAWNEETOWN QUADRANGLE.

Malta west along Texas & Pacific Ry. to De Kalb.

De Kalb, 2.8 miles east of, at railway crossing, 60 feet north of track, in corner of right of way fence; iron post stamped "Prim. Trav. Sta. No. 113, 406"	406.06
De Kalb, in front of station; top of rail	408.5
De Kalb, 1,980 feet west of station, north of track, in corner of right of way fence; iron post stamped "Prim. Trav. Sta. No. 128, 408, 1908"	407.97

BOXELDER QUADRANGLE.

Near Lydia.

Lydia, 0.3 mile east of by 0.3 mile northeast of, spike in root of tree at fork of road	401.61
Lydia, 0.3 mile east of, at junction of roads from Rock Crossing, Dalby Springs, and De Kalb, center of open space at road fork; iron post stamped "389 1908, Prim. Trav. Sta. No. 8"	388.74

Point 5 miles north of Omaha north along highway to Lydia.

John Hagard's house, T road west, head of spike in root of tree at northwest corner of T road	297.93
Rock Crossing, 5 miles south of, 700 feet north of John Hagard's house, 0.8 mile south of White Oak River bottom, T road east; iron post stamped "295" (west of road)	295.38
White Oak River bottom, south edge of, west of road, head of spike in root of large elm tree	251.97
Rock Crossing, on Sulphur River, 0.3 mile south of, at junction of road from west; iron post stamped "Prim. Trav. Sta. No. 7, 296 1908"	296.207

	Feet.
Rock Crossing, 2.3 miles north of, in front of house at fork of road (fork of road leads to Dalby Springs, left hand fork leads to Lydia); iron post stamped "Prim. Trav. Sta., 301, 1908"	300.964
Rock Crossing, 5 miles north of, 6 miles south of Lydia, crossroads at north end of lane near sawmill, southeast corner of; iron post stamped "306 1908"	303.696
J. M. Eitel's house (formerly Millie post office), 1.1 miles north of, 3 miles south of Lydia, west of road, 40 feet north of road fork east, in old field; iron post stamped "Prim. Trav. Sta., 329, 1908"	329.185
Lydia, 0.3 mile east of, at junction of roads from Rock Crossing, Dalby Springs, and De Kalb, center of open space at road fork; iron post stamped "Prim. Trav. Sta. No. 8; 389 1908"	388.741
Lydia, in center of open space, head of spike in root on north side of tree	377.29

Lydia west along highway to Garvensville (Cuthand post office).

Lydia, 2 miles west of, road fork north to Clarksville; head of spike in root of tree	388.79
Lydia, 2.5 miles west of, T road north by small cemetery, north of road on high bank; iron post stamped "373 1908"	373.370
Shawnee Church, 200 feet south of, at fork of road; iron post stamped "364 1908"	363.822
Shawnee Church, 1.1 miles west of, at road fork north, near guide post "Annona 10¾ miles;" head of spike in top of stump	390.96
Boxelder, 1.5 miles east of, southeast corner of T road south, at north end of lane; iron post stamped "360 1908"	360.326
Boxelder, 2.5 miles southwest of, on Cuthand road, east of road, opposite Cole's house; iron post stamped "315 1908"	315.232
Cuthand Creek bottom, 1.2 miles west of edge of, on Garvensvile road, 100 yards west of empty house west of road, at turn at corner of a field; iron post stamped "320 1908"	320.555
Garvensville (Cuthand post office), 4.3 miles east of, at fork of Boxelder and Hartsbluff roads, 0.5 mile north of country church; iron post stamped "376 1908"	375.854
Garvensville, 3.3 miles east of, southeast corner of crossroads; head of spike in root of white oak tree	367.12
Garnersville, 3 miles east of, at T road east; head of spike in root on east side of large double tree	364.33

Goolesboro east along highway to Rock Crossing.

Goolesboro, 0.5 mile east of; iron post stamped "Prim. Trav. Sta. No. 109"	340.324
Goolesboro, 2 miles east of, road fork north, 100 feet east of house; spike head in root of tree	344.82
Goolesboro, 2.8 miles east of, 150 feet from junction of road from north, in front of house; spike head in root of tree	383.48
Sign post "Goolesboro 3 miles," 700 feet east of, north of road on top of small knoll; iron post stamped "390 1908"	389.650
Blalock post office, 0.5 mile south of, 3 miles north of Wilkinson post office, west of road at fork; spike in root of white-oak tree	366.28
Wilkinson post office, 2.2 miles north of, 1.2 miles south of Blalock post office, west of road; iron post stamped "341 1908"	340.685

	Feet.
Wilkinson post office, 1.6 miles north of, at road fork at north end of lane, west of road; spike head in root of large oak tree	336.68
Wilkinson post office, opposite, east of road; iron post stamped "300 1908"	299.814
P. Harris's house, 0.3 mile north of, on Mount Pleasant-Hartsbluff road, 200 feet north of crossroads, west of road; iron post stamped "325 1908"	324.706
Mount Pleasant-Hartsbluff road, 2.8 miles east of, on Rock Crossing road, north of road, opposite northeast corner of field by empty house, on top of small knoll; iron pst stamped "339 1908"	339.784
Jack Wild's ranch, suthwest corner of yard, 1 mile east of house of Arthur Miller; iron post stamped "325 1908"	325.286
Ellis Bridge, crossing White Oak Creek, 1.5 miles north of, 400 feet north of negro schoolhouse on west side of road; iron post stamped "298 1908"	297.201
Ellis Bridge, 0.5 mile north of, at crossroads; head of spike in root of white-oak tree in middle of road	290.47
Ellis Bridge, on White Oak Creek, 0.8 mile east by 0.5 mile north of, 0.7 mile east of slough; head of spike in root of oak tree	302.19
Rock Crossing, 3 miles west of, on Goolesboro road, southeast corner of yard of an empty house owned by James Rogers; iron post stamped "298 1908"	297.635

MOUNT PLEASANT QUADRANGLE.

Omaha west along track of St. Louis Southwestern Ry. Co. of Texas to Mount Pleasant, thence south to Pittsburg.

Cookville, 2.8 miles east of, 40 feet south of track at road crossing, in corner of right of way fence; iron post stamped "404 ADJ 1903"	403.731
Cookville, 1,150 feet west of, 40 feet north of track in fence corner; iron post stamped "440 ADJ 1903"	440.284
Mount Pleasant, 4 miles east of, 1,900 feet east of milepost 476, 40 feet northeast of road crossing; iron post stamped "367 ADJ 1903"	367.541
Mount Pleasant, 0.5 mile north of, 90 feet southeast of road crossing, 80 feet east of tool house; iron post stamped "401 ADJ"	401.021
Mount Pleasant, in front of station; top of rail	401.3
Mount Pleasant, south front of courthouse, 4 feet above ground, in granite railing; bronze tablet stamped "413 ADJ 1903, Prim. Trav. Sta. No. 231"	413.167
Mount Pleasant, 2.5 miles south of, 40 feet west of track at road crossing, in corner of right of way fence; iron post stamped "397 ADJ 1903 Prim. Trav. Sta. No. 12"	396.986
Big Cypress, 1.2 miles north of, 300 feet north of milepost 485, 60 feet west of private road crossing; iron post stamped "293 ADJ 1903"	292.787
Big Cypress, in front of station; top of rail	352.0
Pittsburg, 3 miles north of, 80 feet east of road crossing, at milepost 488, south side of gate; iron post stamped "Prim. Trav. Sta. No. 37, 315 ADJ 1903"	315.439
Pittsburg, 0.2 mile north of, 30 feet west of track, 80 feet southwest of road crossing; iron post stamped "386 ADJ 1903"	385.914

Omaha north along highway 5 miles.

	Feet.
Omaha, 2.3 miles north of, southwest corner of crossroads, head of spike, in root of tree	421.70
Omaha, 4 miles north of, Motley's cotton gin, southeast corner of crossroads; iron post stamped "Prim. Trav. Sta. No. 2, 1908, 325"	324.674
Motley's cotton gin, 0.5 mile north of, T road east, east of road, head of spike in root of large white oak tree	335.74

Mount Pleasant northwest along highway to Payne's store.

Mount Pleasant, 0.5 mile north of station, 80 feet east of tool house by road crossing, in corner of field; iron post stamped "401 ADJ 1903"	401.021
Mount Pleasant, 2 miles north of, 700 feet north of bridge over creek north of two-mile post from Mount Pleasant, east of road; iron post stamped "Prim. Trav. Sta. No. 215, 371 1908"	370.818
Mount Pleasant, 4.5 miles north of, east of road, 400 feet north of road fork east; iron post stamped "Prim. Trav. Sta. No. 193, 461 1908"	460.758
Payne's store, 50 feet northwest of, east of road; iron post stamped "Prim. Trav, Sta. No. 178, 398 1908"	397.788

Cason northwest along highway to Mount Pleasant.

Cason, 50 feet south of track, in corner of yard at railroad crossing, seven telegraph poles west of station; stone marked "U. S. □ B. M." (Coast and Geodetic Survey bench mark)	326.121
Cason, in front of station; top of rail	336.8
Cason, 2.5 miles north of, T road west to Mount Pleasant, head of spike in tree root	370.79
Cason, 3 miles northwest of, on Mount Pleasant road, 0.7 mile south of Swanins Creek, in fork of road near mail box 18; iron post stamped "354 1908"	354.103
Mount Pleasant, milepost 8 miles southeast of, northwest corner of T road west, 0.6 mile south of creek; iron post stamped "358 1908"	357.920
Mount Pleasant, 6.2 miles southeast of, on Cason road, 150 feet north of schoolhouse in fork of road, spike head in root of large oak tree	408.99
Mount Pleasant, 3.8 miles southeast of, at junction of Cason road and Mount Pleasant-Daingerfield road, in fork; iron post stamped "380 1908"	380.140
Mount Pleasant, 3.3 miles southeast of, on Cason road, spike in root of large oak tree in middle of crossroads	362.05

BOGATA QUADRANGLE.

Payne's store north along highway via Goolesboro to Cuthand Creek.

John Thompson's house, 700 feet south of, west of road, at road fork to west, near post holding five mail boxes; iron post stamped "377 1908"	377.464
John Thompson's house, 250 feet north of, nail in root on west side of tree at T road east	373.88
George Baker's house, 400 feet south of, west of road; iron post stamped "Prim. Trav. Sta. No. 154, 336 1908"	336.137

	Feet.
Mount Pleasant 13-mile post, 200 feet north of, east of road; iron post stamped "Prim. Trav. Sta. No. 130, 308 1908"	308.037
Goolesboro, 0.5 mile east of, 1,200 feet north of crossroads, west of road, top of hill at south edge of Sulphur River bottom; iron post stamped "Prim. Trav. Sta. No. 109, 340 1908"	340.324
Sulphur River bridge, 1.3 miles north of, east of road in lane; iron post stamped "Prim. Trav. Sta. No. 86, 330 1908"	330.213
Sulphur River bridge, 2 miles north of, at road fork east and west, nail in root on north side of tree to east of road	333.31
Garvensville (Cuthand post office), 1 mile south of, southeast corner of crossroads; iron post stamped "Prim. Trav. Sta. No. 69, 360 1908"	360.407
Garvensville (Cuthand post office), northeast corner of cemetery, southwest corner of T road west, head of spike in root of tree	373.14
Garvensville (Cuthand post office), 0.8 mile north of, east of road; iron post stamped "Prim. Trav. Sta. No. 59, 409 1908"	409.063

Bonham, Clarksville, Denison, Denton, Gainesville, Montague, and Paris Quadrangles.

COOK, FANNIN, GRAYSON, LAMAR, MONTAGUE, AND RED RIVER COUNTIES.

The elevations in the following list are based on bench marks determined by the precise line of the Coast and Geodetic Survey in the western part of the Montague quadrangle.

Most of the leveling was done by E. W. Glafcke in 1899 and 1900, and by M. S. Bright in 1901, 1902, and 1903. One line in the Clarksville quadrangle was run in 1908 by W. A. Gelbach. The leveling in the Denison quadrangle was done by A. F. Hassan in connection with topographic surveys of the Indian Territory.

MONTAGUE QUADRANGLE.

Terral, Okla., to St. Jo, Tex., via Chicago, Rock Island & Gulf Ry. and Missouri, Kansas & Texas Ry.

	Feet.
Ringgold, 180 feet east of Missouri, Kansas & Texas Ry. station, at end of platform between main tracks and switch; iron post stamped "894 GAINV"	894.650
Ringgold, 3.2 miles east of, 50 feet north of the Missouri, Kansas & Texas Ry. track, and 150 feet east of milepost 752, near railroad fence; iron post stamped "824 GAINV"	824.676
Belcherville, 50 feet north of Missouri, Kansas & Texas station, and 10 feet north of switch at intersection of sidewalk on principal street; iron post stamped "896 GAINV"	896.702
Belcherville, 3.5 miles east of, at public road crossing 6 feet north of track, east side of road; iron post stamped "853 GAINV"	853.382
Nocona, southeast corner of principal street, 200 feet north of station; iron post stamped "980 GAINV"	980.576
Nocona, 3.5 miles east of, 9 rail lengths east of milepost 739; iron post stamped "904 GAINV"	904.555
Nocona, 6 miles east of, at public road crossing 40 feet south of track; 6 telegraph poles west of milepost 737; iron post stamped "892 GAINV"	892.688

	Feet.
Bonita, 200 feet north of Missouri, Kansas & Texas Ry. station; 15 feet north of main track, at base of telegraph pole; iron post stamped "931 GAINV"	931.332
Bonita, 3 miles east of, 25 feet north of track, at milepost 731, public road crosing; iron post stamped "1009 GAINV"	1,009.680
St. Jo, 300 feet east of Missouri, Kansas & Texas Ry. station, 10 feet south of main track near wagon road; iron post stamped "1142 GAINV"	1,141.199

Point 4 miles northwest of Bulcher to Nocona.

Bulcher, 7.2 miles northwest of, A. A. Kennedy's ranch, 800 feet east of house, at intersection of public road and Bonita road; iron post stamped "977 GAINV"	978.461
Bulcher, 11 miles northwest of, 8 miles northeast of Nocona, at junction of Nocona and Illinois Bend roads; iron post stamped "1008 GAINV"	1,009.329
Nocona, 5 miles southeast of, at left side of road, at mouth of lane, east of iron bridge across Farmers Creek; iron post stamped "907 GAINV"	907.910

Nocona southwest via Montague to Bowie and Ringgold.

Nocona, 3 miles southwest of, east side of public road to Montague, in sandstone ledge; aluminum tablet stamped "942 GAINV"	942.879
Nocona, 6.2 miles southwest of, 500 feet due south of Dixie schoolhouse, 10 feet west of public road, 3.5 miles northeast of Montague; iron post stamped "941 GAINV"	941.896
Montague, in west capstone of county courthouse, south side of main entrance; aluminum tablet stamped "1076 GAINV"	1,075.962
Montague, 3.7 miles southwest of, north side of telephone road, 500 feet northwest of farmhouse; iron post stamped "1073 GAINV"	1,073.206
Montague, 6.5 miles southwest of, at turn in north of telephone road, 1,000 feet east of east fork of Denton Creek; iron post stamped "1058 GAINV"	1,057.931
Montague, 10.5 miles southwest of, on high mesa to right of road, 0.8 mile southwest of suspension bridge, 3.8 miles from Bowie; iron post stamped "1127 GAINV"	1,127.455
Bowie, southwest corner of street at Brown Hotel, 100 feet east of Fort Worth & Denver City Ry. station; iron post stamped "1124 GAINV"	1,124.135
Bowie, 2 miles northwest of, top of section of rail west of railroad track for marker at milepost 542	1,051.826
Bowie, 3 miles northwest of, top of section of rail on end in ground for marker at milepost 541	1,015.20
Bowie, 4 miles northwest of, 40 feet east of Chicago, Rock Island & Gulf Ry. track, at public road crossing, 210 feet south of milepost 540; iron post stamped "989 GAINV"	989.628
Bowie, 5 miles northwest of, top of section of rail on end in ground at milepost 539	960.84
Stoneburg, 500 feet west of Chicago, Rock Island & Gulf Ry. station, at northeast corner of post-office building; iron post stamped "936 GAINV"	936.501
Stoneburg, 1.5 miles west of, top of section of rail on end in ground for marker at milepost 534	901.946

	Feet.
Stoneburg, 2.5 miles northwest of, top of section of rail on end in ground for marker at milepost 533	869.025
Stoneburg, 3.5 miles northwest of, top of section of rail on end in ground for marker at milepost 532	863.71
Stoneburg, 4.5 miles northwest of, 50 feet west of track on right of way, 50 feet south of milepost 531, opposite Walker's ranch; iron post stamped "876 GAINV"	876.306
Stoneburg, 5.5 miles northwest of, top of section of rail on end in ground for market at milepost 530	865.93
Stoneburg, 6.5 miles northwest of, top of section of rail on end in ground for marker at milepost 529	869.80
Ringgold, 3 miles south of, 7.5 miles northwest of Stoneburg, intersection of public road and railroad crossing, 1,300 feet north of milepost 528, 46 feet east of railroad track; iron post stamped "897 GAINV"	896.741

Hardy north to St. Jo.

Hardy, 1 mile east of, 600 feet south of Henry Norman's farmhouse, south side of road, top of ridge, in 18-inch post oak tree; spike	1,052.117
Hardy, north side of Gainesville and Montague road, 217 feet west of D. P. McCracken's store; iron post stamped "952 GAINSV"	952.968
Hardy, 1.5 miles north of, northwest side of road, top of ridge in south side of 20-inch broken-top post-oak tree, spike	1,020.065
Gladys, 25 feet west of post office, east side of St. Jo and Hardy road; iron post stamped "1027 GAINSV"	1,028.301
St. Jo, 3.5 miles south of, on west side of St. Jo and Hardy road, 40 feet south of fence corner at angle in road north and west, 0.8 mile south of lane running west; iron post stamped "1167 GAINSV"	1,168.773

Nocona north 6 miles over Nocona and Reed River station road, thence east to Pearson, thence south to railroad.

Nocona, 4 miles northwest of, east side of Nocona and Reed River station road, 10 feet south of lane leading east; iron post stamped "880 GAINSV"	880.756
Nocona, 5.25 miles north of, east side of road at intersection of Red River station road with Seag crossing and Nocona road; iron post stamped "846 GAINSV"	846.750
Pearson post office, 80 feet south of, west side of Spanish Fort and Nocona road, 15 feet south of road leading west; iron post stamped "936 GAINSV"	936.899
Pearson, 3.25 miles south of, 500 feet east of Loving's farmhouse, north side of road leading east and head of lane leading south; bronze tablet set in sandstone rock stamped "909 GAINSV"	910.054

Point 6 miles east of Nocona south over settlement roads via Blue Mound to Dye Mound, thence southwest via Mallard to Fruitland.

Starkeye graveyard, north side at forks, 17 feet east of southwest fence corner; iron post stamped "987 GAINSV"	988.314
Blue Mound schoolhouse, 120 feet south of, south side of St. Jo and Montague road; iron post stamped "1123 GAINSV"	1,124.388
Dye Mound, 0.25 mile northwest of post office, top of ridge at west end of Mound, east side of road by wire fence; iron post stamped "1235 GAINSV"	1,236.436

	Feet.
Mallard, northwest corner C. T. Jester's store and post office; iron post stamped "985 GAINSV"	986.527
Dry Valley schoolhouse, 2 feet north of and 200 feet south of crossroads; iron post stamped "933 GAINSV"	934.519
H. H. McPherson's farmhouse, 150 feet east of, 4 feet north of northwest corner fence post, at crossroads; iron post stamped "1021 GAINSV"	1,022.165

Fruitland along road and railroad west to Lee May's ranch, thence north to Stoneburg.

Fruitland, in west side of stone chimney on south side of house owned by W. H. Searborough, about 5 feet from ground and 6 inches from edge of chimney; copper bolt (Coast and Geodetic Survey bench mark "H")	1,054.061
Bowie, 4 miles south of, 150 feet southeast of Rock Hill schoolhouse, in forks of Park Springs and Bowie and Crafton roads; iron post stamped "972 GAINSV"	973.538
Lee May's ranch house, 2,000 feet south of, east side of road, south end of lane leading north, 4 feet north of fence corner; iron post stamped "1006 GAINSV"	1,007.560
Montague coal mine, 655 feet west of, west edge of chiseled point on sandstone outcrop	984.751
Bowie, 7 miles west of, 0.6 mile north of Z. M. Wilson's farmhouse, south edge of drain, on east side Stoneburg and Newport public road, 856 feet south of crossroads; bronze tablet stamped "1004 GAINSV"	1,005.700
Bowie, 6 miles northwest of, 500 feet west of milepost "Forth Worth 74 Denver 730," 150 feet north of Fort Worth & Denver City R. R. track, at northeast fence corner, head of lane leading north; iron post stamped "995 GAINSV"	996.256
H. A. Speer's farmhouse, 400 feet north of, 4 feet south of southwest fence corner, at crossroads; iron post stamped "947 GAINSV"	948.082
Stoneburg, southwest corner of southwest one of four inner stone blocks supporting water tank, 4 inches from either edge; cross in top of a copper bolt leaded vertically in the stone (Coast and Geodetic Survey bench mark "E")	935.410

Stoneburg east along roads about 3 miles, thence north via Harmony schoolhouse to Belcherville.

Stoneburg, 3.25 miles east of, 600 feet east of bridge over Victoria Creek, 150 feet west of road forks, south side of road at fence corner; iron post stamped "893 GAINSV"	892.907
Belcherville, 4.8 miles south of, south side of Montague and Henrietta road, head of lane leading north to Belcherville; iron post stamped "909 GAINSV"	909.262

Montague southeast to crossing of Forestburg-Montague and Bowie-St. Jo public roads.

Montague, 1 mile southeast of, east side of road in front of house, nail in 16-inch post oak tree	1,077.677
Montague, 4 miles southeast of, south side of road; point on top of milestone 4	1,126.262

GAINESVILLE QUADRANGLE.

St. Jo east to Lindsay.

	Feet.
St. Jo, 3.2 miles east of, 5 telegraph poles east of milepost 723 and 300 feet east of bridge 1453, south side of railroad track, on edge of right of way along public road; iron post stamped "1166 GAINV"	1,166.363
St. Jo, 6.2 miles east of, on east side of public road 60 feet south of Missouri, Kansas & Texas Ry. track, near corner of guard fence; iron post stamped "1036 GAINV"	1,036.696
Muenster, 125 feet northeast of station in southwest corner of lumber yard on principal street; iron post stamped "971 GAINV"	971.632
Myra, 300 feet north of railroad track, west side of public road, opposite and 75 feet east of post office; iron post stamped "917 GAINV"	917.812
Lindsay, southeast corner of Pete Johnson's store on principal street, 750 feet north of railroad track; iron post stamped "796 GAINV"	796.412

Gainesville northwest via Marysville to Bulcher.

Wolf Ridge, 300 feet southeast of schoolhouse 77, at corner of fence forks of Gainesville and farmers roads; iron post stamped "927 GAINV"	928.598
Gainesville, 10.5 miles northwest of, 12 feet southeast of southeast corner post of cultivated land at forks of road, 2 miles north of Wolf Ridge schoolhouse; iron post stamped "945 GAINV"	946.240
Gainesville, 15 miles northwest of, at lower end of Black Hollow, east side of road near top of divide between Black Hollow and Lander Creek; iron post stamped "820 GAINV"	821.047
Marysville, 3 feet south of southwest corner of post office, on east side of principal street; iron post stamped "873 GAINV"	874.714
Marysville, 3 miles northwest of, at junction of St. Jo and Bulcher public roads, at southeast corner of rail fence around Housinger residence; iron post stamped "916 GAINV"	917.698
Bulcher, northwest corner of post office, 40 feet south of Camp Creek, on right bank; iron post stamped "746 GAINV"	747.742
Bulcher, 4.2 miles northwest of, at intersection of Illinois Bend and St. Jo public road, southeast corner of fence west side of road, at J. E. Seitz's farm; iron post stamped "900 GAINV"	901.815

Gainesville via Huneycutt triangulation point, Callisburg, Woodbine, and Burns, northeast, south, and northwest over main county roads to Gainesville.

Gainesville, 3 miles east of, 1,400 feet north of bridge over Wheeler Creek, at right-angle turn of lower Callisburg road, on south side, west side of lane leading south to Whitesboro road; iron post stamped "757 GAINV"	759.259
Gainesville, 8 miles northeast of, at junction of upper Callisburg road and Walnut Bend road, opposite a large spreading elm tree, 4 feet south of Gainesville 8-mile post; iron post stamped "840 GAINV"	841.453
Gainesville, 12 miles northeast of, at Huneycutt triangulation point; bronze tablet stamped "953 GAINV"	954.782
Callisburg, about 5.5 miles northwest of, 1.8 miles due north of Huneycutt triangulation point, 50 feet south of small drain, on east side of Walnut Bend road and north side of road leading east to Callisburg and Ellis Ferry road; iron post stamped "845 GAINV"	847.142

	Feet.
Callisburg, 3 miles north of, on west side of Callisburg and Dexter road, south side of lane leading west to Elliott Ferry; iron post stamped "795 GAINV"	796.959
Callisburg, at northeast corner of George Wright's dry goods and grocery store; iron post stamped "808 GAINSV"	809.441
Callisburg, 3 miles south of, 500 feet south of Spring schoolhouse, 300 feet north of drain, on south side of Gainesville and Whitesboro road and west side of Callisburg and Woodbine road; iron post stamped "774 GAINSV"	775.250
Woodbine, 60 feet north of Missouri, Kansas & Texas Ry. track, at southeast corner of post office and W. R. Crooks's grocery store, on west side of main road; iron post stamped "763 GAINSV"	764.592
Woodbine, 4 miles southwest of, 200 feet south of the Gainesville and Pilot Point upper road, on east side of road leading south to Burns, northwest corner of schoolhouse; iron post stamped "742 GAINSV"	743.461
Burns, on south side of road at northeast corner of J. D. West's grocery store; iron post stamped "680 GAINSV"	681.942
Burns, 2.8 miles west of, 200 feet northeast of Prairie Grove schoolhouse, east side of Gainesville and Pilot Point road, north side of road leading east to Burns; iron post stamped "756 GAINSV"	758.118
Gainesville, 6 miles southeast of, 55 feet west of M. A. Taylor's residence, 60 feet west of large drain, on east side of Gainesville and Pilot Point road, north side of road leading east to schoolhouse; iron post stamped "695 GAINSV"	696.643
Gainesville, 2.5 miles southeast of, about 0.25 mile southeast of crossing on Wheeler Creek, on east side of Gainesville and Pilot Point upper road and south side of road leading east to Pilot Point lower road; iron post stamped "759 GAINSV"	760.964

Wolf Ridge schoolhouse east to Gainesville-Sivells bend road, thence north to Sivells Bend, thence southwest to Marysville via Nubbin Ridge.

Gainesville, 9 miles northwest of, 0.5 mile west of Red River schoolhouse, 500 feet south of a lane leading west to Wolf Ridge, north side of lane leading east to Jim Beaty's ranch, east side main road at fence corner; iron post stamped "851 GAINSV"	852.273
Gainesville, 13 miles northwest of, 1.3 miles northwest of wagon bridge over Fisk Creek, about 400 feet southeast of Lauderdale's house, mouth of lane leading east, at northeast fence corner; iron post stamped "807 GAINSV"	809.096
Gainesville, 18 miles northwest of, in village of Sivells Bend, 0.25 mile west of Dr. Harrison's house, 120 feet east of right-angle turn in main road, at southwest corner of post office, in Greever Bros.' general store, on north side of main road; iron post stamped "874 GAINSV"	875.688
Gainesville, 16 miles northwest of, 0.5 mile south of Bear Head Church, 0.8 mile north of Three Mounds on west side of Gainesville and Burneyville road, at junction of lane leading west to Barlow; iron post stamped "874 GAINSV"	875.917
Gainesville, 17 miles northwest of, west side of Gainesville and Copperas Bluff road, 0.8 mile south of Hickman's house, near head of small drain, at junction of lane leading west to Marysville; iron post stamped "956 GAINSV"	957.214

Lindsay south along public roads via Reed to Era.

	Feet.
Gainesville, 5.5 miles southwest of, 2.8 miles east of Reed post office, 0.25 mile west of J. N. Whaley's house, 160 feet west of small drain, south side of Gainesville and Rosston road; iron post stamped "853 GAINSV"	854.481
Gainesville, 8 miles southwest of, in village of Reed, 600 feet west of lane leading south to Era, north side of Gainesville and Rosston road, at southwest corner of post office, in A. Pulte's store; iron post stamped "952 GAINSV"	953.920
Era, 3.5 miles northeast of, 800 feet northwest of crossing on Spring Creek, in angle of lane on west side of road at the corner of three wire fences, about 0.5 mile south of summit of hill; iron post stamped "829 GAINSV"	830.304

Valley View north to Gainesville.

Gainesville, 7 miles south of, 900 feet south of John Crumley's house and 50 feet north of G. Spearman's house, in angle of road, on west side; iron post stamped "755 GAINSV"	756.591
Gainesville, 4 miles south of, 6 miles north of Valley View, 0.6 mile south of lane running east and west, 0.25 mile north of W. Bedlong's residence, 4 feet east side of road; iron post stamped "754 GAINSV"	755.881
Gainesville, 2.5 miles southwest of, at fence corner in forks of Gainesville, Rosston, and Era roads; iron post stamped "801 GAINSV"	802.102

Reed along public roads southwest via Hood to Rosston, thence northwest to Free Mound.

Hood, 58 feet north of J. H. Hewitt's store and north side of Gainesville and Rosston road; iron post stamped "996 GAINSV"	997.664
Rosston, 3 miles northeast of, 680 feet north of Rosston and Era road, north side small drain and west side Gainesville and Rosston road; iron post stamped "914 GAINSV"	915.129
Rosston, 20 feet south of Raner Bros.' general store, 250 west of J. Dill's store, southwest corner of square; iron post stamped "857 GAINSV"	858.484
St. Jo, 16 miles southeast of, on west side of Free Mound and Rosston road, 100 feet east of Hunter schoolhouse, 300 feet north of bridge over Hunter Creek; iron post stamped "886 GAINSV"	887.387
Free Mound, 62 feet west of post office, in D. P. Wilson's store, on south side of Gainesville and Forestburg road, at corner of wire fence around gin; iron post stamped "884 GAINSV"	885.336

At Gainesville.

Gainesville, in center of north face of top foundation stone at northeast corner of brick building on California Street, near station building, used by Tyler & Simpson as a grocery store; bronze tablet	734.933
Gainesville, 45.3 feet south of south crossing frog, 2 inches out of ground, in line of north and south crossing frogs of Missouri, Kansas & Texas Ry. with the Gulf, Colorado & Santa Fe Ry., 6.4 feet west of west rail of Missouri, Kansas & Texas and 6.8 feet east of east rail of Gulf, Colorado & Santa Fe Ry.; iron post	741.962

Gainesville along Gulf, Colorado & Santa Fe Ry. to Marietta, Okla.

	Feet.
Gainesville, 6 miles north of, about middle of coping stone on east side of north pier of bridge over Red River; copper bolt	662.315

DENTON QUADRANGLE.

Era east to Valley View.

Era, 255 feet north of public school, 60 feet east of Segraves' store, southwest corner of hotel block; iron post	910.322
Valley View, 3 miles west of, at junction of Valley View-Era and Gainesville-Bolivar roads, south side of road, by wire fence; iron post stamped "800 GAINSV"	801.626
Valley View, northeast corner of public square, 10 feet north from front of A. Guston's hotel; iron post stamped "720 GAINSV"	721.806

DENISON QUADRANGLE.

Denison south along the Missouri, Kansas & Texas Ry. to Sherman.

Denison, center of base stone of granite foundation of Ford Building, at corner of Main Street and Rush Avenue, occupied by the National Bank of Denison and numerous offices, on left of avenue entrance; bronze tablet	737.605
Sherman, fire department building, corner of Travis and Cherry Streets, first course of stone foundation, 5.2 feet from south edge of stone, 5.8 feet from north edge of stone on left side of main entrance; bronze tablet	730.068

Choctaw west along Texas & Pacific Ry. to Southmayd.

Choctaw, about 1 mile west of, northeast corner of shoe of angle brace, on north side of bridge 72, over Choctaw Creek; cross on anchor bolt	580.036
Southmayd, 5 miles east of, 20 feet 9 inches south of mile post 160, 48 feet 3 inches south of center of Texas & Pacific Ry. track, and 249 feet west of road crossing; iron post	836.940
Southmayd, 9 feet south of mile pole 165, fourth pole west of station, 46 feet south of center of Texas & Pacific Ry. track; iron post	743.976

Southmayd south to Collinsville along joint line of Texas & Pacific Ry. and Missouri, Kansas & Texas Ry.

Collinsville, 50 feet south of frog of switch, 5 feet 10 inches east of center of track; iron post	747.278

Ethel east along county roads to Howe.

Ethel, northeast corner of intersection of roads, inside fence; iron post	725.743
Ethel, about 6.25 miles east of, northeast corner of intersection of Sherman-Tioga road with Sherman-Howe road, inside fence; iron post	714.810
Howe, about 6.20 miles west of, inside of fence at northeast corner of intersection of roads at William Chisholm's house; iron post	818.456

	Feet.
Howe, 19 feet 6 inches west of center of Houston & Texas Central R. R. track and 49 feet 6 inches north of northeast corner of station building; iron post	843.038
Howe, about 0.8 mile south of, underneath triangulation signal; lead bolt in stone	879.289

Sherman south via Houston & Texas Central R. R.

Sherman, 4 miles south of, lower coping stone west side of south abutment of bridge over Choctaw Creek; copper bolt	654.235

Sherman along county road north to Pottsboro, thence west to Dexter, thence south to Whitesboro.

Pottsboro, 4.75 miles south of, in stone underneath "Good" triangulation signal; copper bolt	882.999
Pottsboro, 6.5 miles west of, southeast corner of Mrs. Carrie Nicholas's front yard, 285 feet north of center of Pottsboro-Gordonville road; iron post	716.019
Gordonville, south of Sanderson's drug store, east of post office, 33 feet south of center of road, on Widow Gordon's place, nearly south of old well in roadway; iron post	721.119
Dexter, 0.75 mile east of, in front garden of J. F. Evans, 62.5 feet south of southwest corner of Evans's house, 63 feet north of center of main road, and about 200 feet west of county line between Cooke and Grayson Counties; iron post	837.759
Dexter, southwest corner of J. F. Cochran's store, building owned by Mrs. T. H. Williams; cross mark cut in foundation stone	781.289
Dexter, 0.5 mile north of, in stone underneath "Dexter" triangulation station; copper bolt	863.57
Dexter, 5.5 miles south of, turn of road east around M. A. Goldston's pasture, about 1,165 feet south of house owned by the Carlock heirs and occupied by Mr. Stuckey, bench mark inside fence; iron post	795.484
Cooke-Grayson county line, 1.7 miles west of, in stone underneath "county line" triangulation signal; copper bolt	884.119
Whitesboro, 3.6 miles west of, at intersection of Dexter road with Gainesville-Whitesboro road, in corner of Dr. Younger's yard and across road from Nance Prairie School; iron post	773.989

Southmayd southeast on county road to Mormon Grove, thence northeast to Sherman.

Southmayd, 6.25 miles southeast of, about 1.25 miles south of Valley Summit School, in Halliday's field, across road from Mrs. Keene's pasture, about 20 feet east of the center of road and 2 feet north of division fence, 600 feet south of head of a timbered drain flowing southwest; iron post	760.384
Mormon Grove, 550 feet northeast of, cross mark cut in stone underneath "Mormon Grove" triangulation station; copper bolt in stone about 2 feet under surface	901.029
Sherman, 3 miles southwest of, inside fence at turn of road to east and directly opposite gate on other side of lane; iron post	801.759

North along county road from Pottsboro to meander corner on Red River of T. 8 S., Rs. 5 and 6 E., of the Chickasaw survey.

Fink, 24 feet north of road to Bounds Ferry, inside of fence, west of the post office; iron post	710.489
Fink, 2 miles west of, in stone underneath "Fink" triangulation station; copper bolt	839.69

At Denison.

	Feet.
Denison, corner of Texas Street and Austin Avenue, in front yard, near gate opening on Texas Street, property known as "Stuart place;" iron post	757.129

Pottsboro west to Woodbine along Missouri, Kansas & Texas Ry.

Pottsboro, foundation stone of southwest corner of brick and stone building owned and occupied by J. E. Reeves; bronze tablet	767.693
Steedman, 50 feet south of track and 100 feet east of section house, 1 foot above surface of ground (name of railroad station is Deaver); iron post	631.897
Whitesboro, 3.5 feet above ground and 15 inches from southeast corner on east side of brick school building; bronze tablet	821.538
Woodbine, 2 miles east of, south side of east end bridge over Timber Creek, about 30 feet from mile pole 691, cross mark on southwest end of coping stone	699.538

BONHAM QUADRANGLE.

Point 2 miles east of Bonham southeast and northeast along highway and railroad to Honey Grove.

Bonham, 5 miles east of, 600 feet east of Tom Hilton's cotton gin, 100 feet northeast of house, south of road; iron post stamped "618 PARIS"	647.879
Bonham, 8.7 miles east of, 3.5 miles south of Dodd City, corner of fence, at fork of roads to Dodd City and Shady Grove; iron post stamped "662 PARIS"	691.984
Bonham, 12 miles east of, 50 feet north of Leonard Huff's house, 12 feet east of Windom road and 5 feet south of Bonham road; iron post stamped "636 PARIS"	665.514
Bonham, 15.5 miles east of, 770 feet west of Wood's house, at big gate south of road; iron post stamped "619 PARIS"	648.203
Honey Grove, 5 miles southwest of, 100 feet north of C. M. Yeager's house, in solid stone on west side of Honey Grove-Cox Bridge road; aluminum tablet stamped "618 PARIS"	646.554

Savoy to Honey Grove via Ravenna, Ivanhoe, and Lamasco.

Savoy, 4 miles northeast of, 600 feet southeast of Powers's ranch house, 800 feet west of Pottiela Creek, 8 feet south of road, in large sandstone ledge; aluminum tablet stamped "594 PARIS"	595.772
Ravenna, on principal street, southeast corner of frame building used as post office; iron post stamped "597 PARIS"	599.010
Ivanhoe, 3 miles west of, 5.5 miles east of Ravenna, 0.5 mile east of intersection of crossroads, on south side of road; iron post stamped "593 PARIS"	594.705
Ivanhoe, northeast corner of fence around Sam Keene's residence on principal street; iron post stamped "606 PARIS"	608.077
Ivanhoe, 3 miles east of, 250 feet south of intersection of Bonham road, 40 feet north of gate to Atkin's ranch, east side of road; iron post stamped "607 PARIS"	608.974

	Feet.
Lamasco, southwest corner of Windle & Goodman store building; iron post stamped "587 PARIS"	588.300
Bois d'Arc Creek, 1.5 miles east of, 8.5 miles north of Honey Grove, at end of lane on north side of road at turn south; iron post stamped "520 PARIS"	521.795
G. B. Crumpeeker's farm, southeast corner of fence around house, 300 feet east of intersection of Bonham, Paris, and Honey Grove roads; iron post stamped "614 PARIS"	615.633

CLARKSVILLE QUADRANGLE.

Paris east along Texas & Pacific Ry. to Clarksville.

Blossom, 250 feet east of station, 100 feet north of track, east side of sidewalk; iron post stamped "525 PARIS"	526.683
Detroit, 100 feet southeast of station, 40 feet south of track, on west side of principal street on right of way; iron post stamped "481 PARIS"	482.782
Bagwells, 150 feet south of station, northwest corner of Dr. W. C. Stephen's drug store; iron post stamped "475 PARIS"	476.842
Clarksville, east face of county courthouse, north side of main entrance; aluminum tablet stamped "431 PARIS"	432.369

Clarksville west to Paris via Faught post office.

Clarksville, 3.51 miles north of, at intersection of Clarksville-Albion road, southeast corner of J. A. Jamieson's fence; iron post stamped "465 PARIS"	466.966
Clarksville, 8.51 miles northwest of, at intersection of Bagwells and Manchester public roads, 4 miles northeast of Bagwells, 500 feet south of A. L. Cook's house; iron post stamped "481 PARIS"	482.309
Detroit, 10 miles north of, intersection of Clarksville, Pine Bluffs, Detroit, and Manchester public roads, southwest corner of Newell & Hubbard's farm fence, 1,200 feet west of main crossroads, on north side of road; iron post stamped "509 PARIS"	510.770
Woodland, 5.31 miles west of, 16.51 miles northeast of Paris, 200 feet north of J. P. Haigood's farmhouse, on north side of road alongside rail fence; iron post stamped "468 PARIS"	470.297
Faught, 100 feet southeast of post-office building, at intersection of Paris and Blossom public roads; iron post stamped "492 PARIS"	494.044
Givens, 150 feet west of building used as post office, at junction of Paris and Pine Bluffs road with Slate Shoal road, alongside rail fence; iron post stamped "506 PARIS"	507.753

Cuthand Creek north to Clarksville.

Stanley, 1.5 miles south of, 1,250 feet south of B. C. Wolf's house, east of road; iron post stamped "Prim. Trav. Sta. No. 29-366-1908"	365.749
Clarksville, 2.8 miles south of, 100 feet north of bridge over small stream, west of road; iron post stamped "Prim. Trav. Sta. 15-390-1908"	389.708

PARIS QUADRANGLE.[1]

Honey Grove south and east along road south of railroad to Paris.

	Feet.
Honey Grove, 3.7 miles south of, 440 feet southeast of Horace Jones's house, on south side of road; iron post stamped "600 PARIS"	601.722
Honey Grove, 6.7 miles east of, corner of Mrs. C. Jones's yard house, 100 feet south of intersection of Union-Petty road, on south side of public road and 20 feet west of Union-Petty road; iron post	569.498
Honey Grove, 10 miles east of, on north and south ridge, north side of road, 125 feet north of Smith Rollin's house; iron post	589.464
Honey Grove, 13.5 miles east of, south side of road, 20 feet west of bridge over creek; iron post	522.287
Ambia, 45 feet south of Gulf, Colorado & Santa Fe Ry. station, 27 feet west of main track; iron post	552.202
Honey Grove, 21 miles east of, 4 miles south of Paris, at public road crossing, 10 feet northeast of dirt road, 15 feet northwest of railroad crossing, 800 feet southeast of Ben Price's house; iron post	537.094

Honey Grove to Paris via Tiger Town and Maxey.

Honey Grove, in bottom step of approach to First National Bank, corner Fifth and Market streets; copper bolt stamped "675 PARIS"	676.995
Michigan schoolhouse, northeast corner of fence, 7 miles northeast of Honey Grove (by Monkston road), 50 feet northwest of W. Hutchinson's farmhouse; iron post stamped "607 PARIS"	608.858
Tiger Town, Cothron's store, 30 feet northeast of post-office building, at corner of fence; iron post stamped "559 PARIS"	561.000
Maxey, northwest corner of post-office building, W. J. Wheeler's store; iron post stamped "569 PARIS"	570.519
Paris, 3 miles west of, 300 feet west of bridge over Pine Creek, south side of road; iron post stamped "494 PARIS"	495.501
Paris, post-office building, right side of entrance, in first step; aluminum tablet stamped "601 PARIS"	602.667

Dallas, Farmersville, McKinney, and Rockwall 30′ quadrangles.

COLLIN, DALLAS, KAUFMAN, AND ROCKWALL COUNTIES.

The elevations in the following list were determined by primary leveling extended from bench marks of the Coast and Geodetic Survey precise level line along the Missouri, Kansas & Texas Ry. at Rockwall and Rowlett. No connection was made with the Coast and Geodetic Survey bench mark at Garland.

The leveling was done by W. A. Gelbach in 1909, in cooperation with the State.

ROCKWALL QUADRANGLE.

Rockwall southwest along Missouri, Kansas & Texas Ry. to East Fork of Trinity River, thence along highway north 4.5 miles.

	Feet.
Rockwall, southwest corner of courthouse, in south face, 4 feet above ground; copper bolt (Coast and Geodetic Survey bench mark "G 2")	595.749

[1] The error distributed in this line is excessive.

	Feet.
Rockwall, south end of Missouri, Kansas & Texas Ry. station, opposite cistern; top of rail	553.4
Rockwall, 2.5 miles southwest of, at Missouri, Kansas & Texas Ry. bridge over East Fork of Trinity River, north end of east pier: aluminum tablet stamped "Prim. Trav. Sta. No. 4, 1909, 417"	417.30
Rockwall, 1.5 miles west by 1.9 miles south of, 13 feet from primary traverse station 343, corner of brush land; copper nail in root of tree	412.41
Rockwall, 1.5 miles west by 1.5 miles south of, 30 feet north of primary traverse station 344; copper nail in leaning bois d'arc tree	412.42
Rockwall, 1.5 miles west by 0.3 mile south of, primary traverse station 350 plus 142.5; copper nail in bois d'arc stump	414.24
Rockwall, 1.5 miles west of, 40 feet south of road, about 40 feet east of slough bridge, in edge of timberland; iron post stamped "Prim. Trav. Sta. No. 13, 1909, 416"	415.809
Rockwall, 1.5 miles west by 0.8 mile north of, 150 feet south of Rockwall-Dallas road, at primary traverse station 361; copper nail in root of elm tree	413.75
Rockwall, 1.5 miles west by 1.6 miles north of, 26.6 feet west of primary traverse station 365; copper nail in root of bois d'arc tree	418.82

Point 4.8 miles north by 1.5 miles west of Rockwall north 2 miles.

Rockwall, 5 miles north by 1.5 miles west of, 35 feet northeast of primary traverse station 384, in edge of timber; copper nail in hackberry tree	427.57
Rockwall, about 5.5 miles north by 1.5 miles west of, northeast corner of N. F. Evan's field, south side of road; iron post stamped "Prim. Trav. Sta. No. 15, 1909, 433"	433.046
Rockwall, 6 miles north by 1.5 miles west of, 39 feet west of primary traverse station 389, on line between two fields; copper nail in root of water elm tree	431.24
Rockwall, 6.4 miles north by 1.5 miles west of, 16.4 feet north of primary traverse station 391, in fence line; copper nail in elm tree	432.71
Rockwall, 7 miles north by 1.5 miles west of, primary traverse station 393 plus 119.3, on river bank; copper nail in root of water elm tree	435.82

Point near Rockwall south to point 2 miles north of Barns Bridge.

Barns Bridge, 4.5 miles north of, east of road, 20 feet west of river bank; copper nail in root of burr oak tree	407.84
Barns Bridge, 3.9 miles north of, 51.5 feet from primary traverse station 112; nail in root of leaning burr oak tree	405.05
Barns Bridge, 3.3 miles north of, 2.5 miles south of Missouri, Kansas & Texas Ry. bridge, 300 feet east of river; iron post stamped "Prim. Trav. Sta. No. 5, 403, 1909"	403.602
Barns Bridge, 2.7 miles north of, 29.5 feet from primary traverse station 129; copper nail	402.78

Point on Dallas and Forney road 5.8 miles south of Barns Bridge.

Barns Bridge, 5.8 miles south of, 800 feet south of bridge over East Fork of Trinity River, at turn of road, near slough, 40 feet south of road corner, on Dallas-Forney road; iron post stamped "Prim. Trav. Sta. No. 9, 1909; No. 29, 1909"	383.581

DALLAS QUADRANGLE.

Point 1.6 miles north by 1.5 miles west of Rockwall north 3.2 miles.

	Feet.
Rockwall, 1.5 miles west by 2.1 miles north of, 4.5 feet southwest of primary traverse station 368, on bank of river, copper nail in root of 20-inch leaning oak tree	421.69
Rockwall, 1.5 miles west of by 2.5 miles north of, primary traverse station 369 plus 519.7, 100 feet east of river, copper nail in root of spotted oak	422.10
Rockwall, 2.8 miles north by 1.5 miles west of, about 2 miles north of Rockwall-Dallas road, 400 feet east of East Fork of Trinity River, in west edge of timber; iron post stamped "Prim. Trav. Sta. No. 14, 1909, 422"	422.362
Rockwall, 3.1 miles north by 1.5 miles west of, 63.2 feet east of primary traverse station 375, copper nail in root of 16-inch hackberry tree	424.14
Rockwall, 4.1 miles north by 1.5 miles west of, 5.7 feet west of primary traverse station 378, in edge of timber, 40 feet west of river, copper nail in mulberry tree	427.87
Rockwall, 4.3 miles north by 1.5 miles west of, 5 feet west of primary traverse station 379, copper nail 20-inch oak in edge of timber by Geo. Rogers's field	426.62
Rockwall, 4.8 miles north by 1.5 miles west of, 100 feet west of slough, copper nail in top of bois d'arc stump, at primary traverse station 382	427.56

Point near Barns Bridge south along highway and west along Texas & Pacific Ry. to Mesquite, thence north along highway to Rowlett.

Barns Bridge, 2 miles north of, at primary traverse station 135, copper nail in top of stump 2 feet high near edge of field	401.99
Barns Bridge, 1.5 miles north of, primary traverse station 140; copper nail in notch in base of mulberry tree	399.583
Barns Bridge, 1 mile north of; iron post stamped "Prim. Trav. Sta. No. 6, 1909, 399"	398.870
Barns Bridge, on east bank of river, above; copper nail in base of red elm	396.990
Barns Bridge, 130 feet east of, in field south of road; iron post stamped "Prim. Trav. Sta. No. 7, 1909, 408"	408.257
Barns Bridge, 0.7 mile south of, primary traverse station 158; copper nail in 6-inch stump 15 inches high	397.270
Barns Bridge, 1 mile south of, primary traverse station 159; nail in root of old bois d'arc stump in open ground	395.920
Barns Bridge, 1.4 miles south of, primary traverse station 163; copper nail in small stump 15 inches high	394.000
Barns Bridge, 1.9 miles south of, primary traverse station 166; copper nail in top of 8-inch stump	391.830
Barns Bridge, 2.4 miles south of, primary traverse station 173, 250 feet south of fence; nail in root of leaning white ash	388.850
Barns Bridge, 2.9 miles south of, primary traverse station 177; copper nail top of 8-inch stump	391.520
Barns Bridge, 3.4 miles south of, about 0.8 mile north of Dallas-Forney road, 320 feet south of corner of wire fence at east and west lane, 18 inches west of wire fence on land of Jeff Caldwell; iron post stamped "Prim. Trav. Sta. No. 8, 1909, No. 17"	389.446

	Feet.
Barns Bridge, 4.2 miles south of, primary traverse station 184 plus 898; copper nail in root of tree	388.69
Barns Bridge, 5 miles south of, primary traverse station 191 plus; copper nail in hackberry tree	382.41
Barns Bridge, 6.9 miles south of, primary traverse station 204, 75 feet southwest of levee; copper nail in leaning elm at corner of field	381.02
Mesquite, 5.4 miles east of, Texas & Pacific Ry. crossing of East Fork of Trinity River, 48 feet east of northeast corner of wagon bridge, about 15 feet north of center of wagon road, 162 feet south of center of railway water tank; iron post stamped "Prim. Trav. Sta. No. 10, 1909, No. 22"	383.817
Mesquite, 3.8 miles east of, 1.8 miles west of East Fork of Trinity River, 25 feet south of track, west side of road, at crossing; iron post stamped "1909"	446.002
Mesquite, 350 feet east of station, at crossing; top of rail	496.8
Mesquite, 500 feet west of station, 100 feet north of tracks; iron post stamped "Prim. Trav. Sta. No. 11, 1909, No. 25"	484.159
Mesquite, 2.5 miles north of, T road south; copper nail in northwest corner of iron bridge over North Mesquite Creek	483.95
Newhope, 150 feet north of main crossroads, east side of road; iron post stamped "Prim. Trav. Sta. No. 22, 1909"	534.107
Newhope, 1.5 miles north of, 1.5 miles south of Rose Hill (Housley), 20 feet east of north end of bridge over Duck Creek; iron post stamped "Prim. Trav. Sta. No. 21, 1909"	444.705
Rose Hill (Housley), 300 feet east of road fork, 100 feet southeast of blacksmith shop, by wire fence; iron post stamped "Prim. Trav. Sta. No. 20, 1909, 505"	504.427
Rowlett, 2.2 miles south of, 20 feet south of southeast corner of bridge over Rowlett Creek; iron post stamped "1909"	421.60

Barns Bridge west along highway to Newhope.

Barns Bridge, 1 mile west of, south side of road, opposite corner of timber land, in root of bois d'arc stump; copper nail	396.09
Newhope, 2.6 miles northeast of, 30 feet south of west end of bridge over Duck Creek; iron post stamped "1909"	428.592

Rowlett southeast along highway to point near Barns Bridge.

Rowlett, 1.5 miles east of, 30 feet south of west end of west Missouri, Kansas & Texas Ry. bridge over Muddy Creek, in corner of right of way fence; iron post stamped "423 1909"	423.303
Rowlett, 3.3 miles southeast of, 0.5 mile below junction of Muddy Creek and Rowlett Creek, 0.2 mile north of bridge over Rowlett Creek, 300 feet northeast of levee; copper nail in east side of dead bois d'arc tree	412.63
Rowlett, 3.4 miles southeast of, 600 feet northwest of bridge over Rowlett Creek; copper nail in northwest corner of small bridge	412.23
Rowlett, 4 miles southeast of, 0.5 mile below bridge over Rowlett Creek, 40 feet east of bank of Rowlett Creek; copper nail in east side of tree	409.81

	Feet.
Rowlett, 4.2 miles southeast of, east creek bank, 300 feet north of levee, at edge of field; copper nail in leaning bois d'arc tree	409.98
Barns Bridge, 3 miles northwest of, iron bridge over Rowlett Creek, 10 feet north of east end of bridge; iron post stamped "407, 1909"	407.028

Rose Hill (Housley) northwest to Garland, thence northeast and southeast to Rowlett.

Centerville, 3.4 miles southeast of Garland, 2.9 miles northwest of Rose Hill, 100 feet east of J. M. Davis & Bros.' store, north side of road at crossroads; iron post stamped "538 1909"	537.958
Garland, 0.3 mile southeast of station, 500 feet south of Missouri, Kansas & Texas Ry., about 500 feet east of crossing of Missouri, Kansas & Texas Ry. and Gulf, Colorado & Santa Fe Ry., top of northeast corner post of concrete bridge; mark X, painted in black	527.84
Garland, crossing of Missouri, Kansas & Texas Ry. and Gulf, Colorado & Santa Fe Ry.; top of rail	537.7
Garland, in front of Missouri, Kansas & Texas Ry. station; top of rail	540.6
Garland, 1 mile west of, south end of west pier of Missouri, Kansas & Texas Ry. bridge over Duck Creek; aluminum tablet stamped "Prim. Trav. Sta. No. 2, 1909, 551"	550.413
Garland, 0.2 mile north of, at Gulf, Colorado & Santa Fe Ry. crossing; top of rail	543.1
Sachse, 2.5 miles southwest of, Gulf, Colorado & Santa Fe Ry., at crossing; top of rail	527.6
Garland, about 3.5 miles northeast of, 200 feet west of fork of road to southwest, near house in small grove, in northeast corner of bridge; top of bolt	508.93
Rowlett, 4 miles northwest of, 20 feet from southwest corner of iron bridge over Rowlett Creek; iron post stamped "453 1909"	452.695
Rowlett, 1.2 miles north of by road, T road northeast, west end of culvert; copper nail	517.77
Rowlett, crossing of Missouri, Kansas & Texas Ry., about 1,000 feet west of station; top of rail	506.9
Rowlett, in angle formed by right of way fence and fence at road crossing about 700 feet east of station, 16 paces north of center of railroad track, 4 paces west from crossing, and between fourth and fifth telegraph poles east of station; bottom of square hole cut in top of limestone post marked "U. S. □ B. M." (Coast and Geodetic Survey bench mark F-2)	504.991

Point 6 miles northwest of Rowlett north to Murphy.

NOTE.—On account of an error of about 1 foot in the line from Rowlett via Murphy to point 3 miles east of Wylie, of which this line forms a part, the fraction only has been adjusted, leaving a discrepancy of 1 foot to be found.

Sachse, 1.5 miles southwest of, east end of north pier of Gulf, Colorado & Santa Fe Ry. bridge 6134 over Rowlett Creek, 3.5 miles north of Garland; aluminum tablet stamped "Prim. Trav. Sta. No. 19, 1909, 480"	478.726

	Feet.
Sachse, Gulf, Colorado & Santa Fe Ry. crossing, south of station; top of rail	550.2
Murphy, 1 mile south of, southeast corner of cross roads, copper nail in root of elm tree	565.79

M'KINNEY QUADRANGLE.

Murphy east to point 1 mile east of Wylie.

NOTE.—On account of a gross error of nearly 1 foot in the line from Rowlett via Murphy to point 3 miles east of Wylie, of which this line forms a part, the fraction only has been adjusted, leaving a discrepancy of 1 foot to be found.

Murphy, 1,200 feet south of St. Louis Southwestern Ry. Co. of Texas station, southwest corner of crossroads near picket fence; iron post stamped "Prim. Trav. Sta. No. 18, 1909, 576"	575.033
Murphy, at crossing west of station; top of rail	576.6
Wylie, about 0.2 mile south of main part of town, front of T road north; iron post stamped "Prim. Trav. Sta. No. 17, 1909, 547"	545.655
Wylie, 1 mile east of, about 100 feet north of fork of road, copper nail in root of leaning tree	465.51

FARMERSVILLE QUADRANGLE.[1]

Point 1 mile east of Wylie east 2 miles.

Wylie, 3 miles east of, 1,350 feet west of bridge over East Fork of Trinity River, south side of public road; iron post stamped "Prim. Trav. Sta. No. 16, 1909, 450." (Adjusted elevation 1 foot greater.)	448.574

Brenham, Bryan, Hearne, Marlin, Sealy, Taylor, Temple, and Waco 30′ quadrangles (including various 7½′ quadrangles along Brazos and Little rivers).

AUSTIN, BELL, BRAZOS, BURLESON, FALLS, McLENNAN, MILAM, ROBERTSON, WALLER AND WASHINGTON COUNTIES.

The elevations in the following list were determined by primary leveling extended from bench marks of the Coast and Geodetic Survey precise leveling near Sealy, Temple, and Waco.

The State cooperated in the leveling, which was done in the Sealy 30′ quadrangle in 1909 by E. L. McNair, C. H. Semper, and F. H. West; in the Brenham 30′ quadrangle in 1909 by McNair, Semper, and West, and in 1910 by West and F. J. McMaugh; in the Bryan 30′ quadrangle in 1909 by Semper and West, and in 1910 by West and Thomas; in the Hearne 30′ quadrangle in 1909 by McNair and Semper, and in 1910 by West and P. W. McMillen; in the Marlin 30′ quadrangle in 1909 by Semper, and in 1910 by McNair, McMillen, and West; in the Taylor quadrangle in 1909 by McNair, and in 1910 by McNair and McMillen; in the Temple 30′ quadrangle in 1910 by McNair and West; and in the Waco 30′ quadrangle in 1909 by Semper, and in 1910 by West.

[1] On account of a gross error of nearly 1 foot in the line from Rowlett via Murphy to point 3 miles east of Wylie, of which this line forms a part, the fraction only has been adjusted, leaving a discrepancy of 1 foot to be found.

SEALY QUADRANGLE.

McDowell Bridge north along highways to Steel farm.

	Feet.
McDowell, 0.5 mile east of, on the Missouri, Kansas & Texas Ry., on bridge 2156 over Brazos River, at south end of first pier west of Austin and Waller County line, on top surface of southernmost short section of rail resting on cement pier, 2.5 centimeters (about 0.83 inch) square, chiseled in outline between two transverse girders (Coast and Geodetic Survey bench mark "87")	124.510
McDowell, 0.5 mile east of, on top of iron cylinder pier, west end of bridge, twin cylinder piers, bench mark on pier up river, at joining of west span and trestle (Brazos River Survey, U. S. Army Engineers, elevation 130.62)	124.202
McDowell, 0.5 mile east of, Missouri, Kansas & Texas Ry. bridge over Brazos River, south side, top of east abutment; aluminum tablet stamped "129 1 Prim. Trav. Sta. 10"	129.255
McDowell Bridge, 2.1 miles north of, 300 feet east of Orange Creek, 5 feet west of gate at Charles Taylor's farm, south side of road; iron post stamped "126 2 Prim. Trav. Sta. 11"	125.631
McDowell Bridge, 3.1 miles north of, north of road, in root of elm tree; spike marked "U. S. B. M. 125"	125.25
Junction of main road with lane down Orange Creek, east margin of road, spike in root of 48-inch pecan tree; marked "U. S. B. M. 131"	130.84
Wendts Ferry, about 1.3 miles southeast of, in front of Lee Penrise farmhouse, south side of road, at front yard fence; iron post stamped "130 3 Prim. Trav. Sta. 12"	130.411
Fork of road to Wendts Ferry, southwest corner, spike in root of hackberry tree; marked "U. S. B. M. 126"	125.66
McDowell Bridge, 6.9 miles north of, 0.3 mile north of Wendts Ferry, in front of house on Frank Meyer's place, occupied by Allen McDowell (colored), north side of road, at fence line; iron post stamped "124 4 Prim. Trav. Sta. 13"	124.029
Wesley Church (colored), 250 feet northwest of, 10 feet north of road, 15 feet west of hackberry tree; iron post stamped "128 5 Prim. Trav. Sta. 14"	128.236
McDowell Bridge, 11.2 miles north of, at three corners, Tom Sterling's land, house occupied by Reader Manning (colored); iron post stamped "135 6 Prim. Trav. Sta. 15"	134.696
McDowell Bridge, 13.4 miles north of, at corner of Joe Robinson's land, 150 feet northwest of house occupied by Richard Hamilton (colored), at corner of fence, side of road; iron post stamped "136 7 Prim. Trav. Sta. 16"	135.645
Sunnyside, 0.5 mile west of, at four corners, southeast corner, east side of road; iron post stamped "170 8 Prim. Trav. Sta. 17"	170.400
Sunnyside, north of, east side of road, in branch bottom, spike in root of post oak; painted "153"	152.50
Sunnyside, 2.4 miles north of, on J. C. Willis's farm, 350 feet west of house, 50 feet west of road to north, 10 feet east of 5-foot post oak; iron post stamped "155 9 Prim. Trav. Sta. 18"	155.330
Walter Lofton's farm, 1,000 feet north of house, on east margin of road, spike in root of hackberry tree; painted "147"	146.90
Sunnyside, 4.1 miles north of, at west edge of cotton field, 6 feet north of road, 10 feet south of 4-foot ash; iron post stamped "149 10 Prim. Trav. Sta. 19"	149.408

	Feet.
Steel farm, 0.5 mile south of bridge over Clear Creek, at corner of wire fence, pecan tree used as corner post; iron post stamped "144 11 Prim. Trav. Sta. 20"	144.038
McDowell Bridge north along highways to point 1.3 miles south of Cochran.	
San Felipe, 0.5 mile east of, at junction of McDowell-San Felipe road and south road to Wendt Ferry; iron post stamped "124"	124.078
San Felipe, 600 feet west of Methodist Church, on north side of road midway between T roads north and south, spike in root of 5-inch tree; marked "153"	152.88
San Felipe, 0.8 mile north of Methodist Church, on west side of road to Burleigh, just north of small bayou, 1,200 feet north of cross-roads; iron post stamped "127"	127.145
San Felipe, 1.7 miles north of Methodist Church, on road to Burleigh in front yard of Arthur Washington's place at T road to San Felipe, spike in stump of 12-inch chinaberry tree; marked "154.1"	153.96
Sealy, 4 miles northeast of, on John Mueller's place, 800 feet west of house on north side of lane from main road, about 900 feet east of main road to Bellville; iron post stamped "158"	158.210
Mills Creek, 100 feet north of, north end of upper steel bridge over creek on north side of road, 75 feet east of house occupied by Squire Campbell on Lewis Downley's plantation; iron post stamped "129"	129.165
Mills Creek Bridge, 0.8 mile northeast of, on north side of road to Burleigh, 0.4 mile south of Macedonia negro schoolhouse, where road makes angle to north; spike in root of 24-inch hackberry tree, marked "127.4"	127.26
Macedonia schoolhouse, 0.4 mile north of, on east side of road through fields to Burleigh, in front of John Matthew's cabin; spike in root of 15-inch oak, marked "133.4"	133.20
Hack's ginhouse, 300 feet northwest of, 75 feet west of road along fence line; spike in root of 24-inch pecan tree, marked "137.4"	137.16
Hack's ginhouse, 0.5 mile north of, on west side of road up river, 300 feet northwest of cabin to east of road, 500 feet southeast of cabin to west of road, 0.5 mile south of Fort's house; iron post stamped "140"	139.332
R. C. Fort's house, 0.8 mile north of, on east side of road up river, on edge of river bank; spike in root of 12-inch cottonwood tree which stands somewhat alone in clearing, marked "136.9"	136.66
George Morgan's house, 75 feet southwest of; spike in root of stump on west side of road, marked "138.3"	138.08
Feorn Keoeurather's place, 300 feet south of Ed. Currey's cabin, 20 feet south of ditch across cotton field, 0.5 mile southeast of Miller's gin; iron post stamped "144"	143.401
Miller's gin, 1.3 miles north of, at junction of main road to Bellville and road through Buck's bottom; spike in root of 15-inch oak at northwest corner, marked "141.1"	140.82
Buck's gin, 0.5 mile south of, at northeast edge of Buck's bottom, 20 feet west of road at gate, 600 feet north of Williams's negro cabin; iron post stamped "141"	140.927
Buck's gin, 0.5 mile northeast of, at northeast end of lot for Buck's quarters, 1,000 feet north of Abe Wright's negro cabin; spike in root of smaller of two oaks that stand together, 300 feet south of fence, marked "154.2"	153.87

BRENHAM QUADRANGLE.

Steel farm northwest along highway along east side of river to Harmon.

	Feet.
Steel farm, 0.5 mile north of, gate of farmhouse, east side of road; iron post stamped "152 12 Prim. Trav. Sta. 21"	151.884
Steel farm, at corner of wire fence front of shanty, in top of guard post; spike painted "160"	160.20
Steel farm, west side of road, 200 feet south of gate, spike in root of post-oak tree; painted "180"	180.05
Steel farm, 3 miles north of, on road to Hempstead, 600 feet south of fork in road to Lewisville, 15 feet east of road; iron post stamped "190 13 Prim. Trav. Sta. 22"	189.676
Steel farm, 6 miles north of, on road to Lewisville, 0.5 mile west of Hempstead road, north side of road, in edge of woods; iron post stamped "202 14 Prim. Trav. Sta. 23"	205.184
Lewisville Church, 0.8 mile northwest of, on Crooks's land, 500 feet north of house occupied by John Bush (colored), west side of road; iron post stamped "185 15 Prim. Trav. Sta. 24"	187.584
Hempstead, 3.2 miles west of, on Houston & Texas Central R. R., 200 feet east of wooden bridge, 800 feet west of Pointer station sign, 80 feet south of track; iron post stamped "211 16 Prim. Trav. Sta. 25"	213.578
Harmon, 0.8 mile west of, Houston & Texas Central R. R. bridge over Brazos River, south side, top of east pier; aluminum tablet stamped "169 17 Prim. Trav. Sta. 26"	171.814
Brazos River Bridge, top of west pier, no mark (U. S. Army Engineers' elevation 196.01)	171.55

Point near Harmon north along west side of Brazos River to Washington.

New Years Creek, county bridge over, east side, top of north abutment; aluminum tablet stamped "165 18 Prim. Trav. Sta. 27"	164.923
McGregor farm, south side of road, spike in root of pecan tree; painted "163"	163.02
Grand Point, opposite, east side of road, spike in root of elm tree; painted "158"	157.82
Riverside plantation, 0.5 mile west of, 200 feet south of gate to lane, opposite old house, at west margin of road; iron post stamped "164 19 Prim. Trav. Sta. 28"	163.742
Henry Hughes's plantation, at edge of river, spike in root of Spanish oak tree; painted "168"	167.74
R. R. Felder's farm, west side of road, spike in root of ash tree; painted "168"	167.57
J. F. Buchanan's land, at southwest line, 30 feet north of old river levee, at road to negro houses; iron post stamped "168 20 Prim. Trav. Sta. 29"	167.787
J. F. Buchanan's land, 0.25 mile west of house, on west side of road, spike in root of elm tree; painted "167"	166.68
J. F. Buchanan's land, north side of road, spike in root of ash tree; painted "167"	167.09
Buchanan's house, 130 feet north of, on Giddings & Buchanan's land, north end of dam across Jackson Creek, at end of wire fence; iron post stamped "171 21 Prim. Trav. Sta. 30"	171.062
Giddings & Buchanan's land, near house occupied by Jim Franklin, spike in root of Spanish oak; painted "192"	192.43

	Feet.
Lott's place, east side of road, spike in root of Spanish oak; painted "192"	191.51
Jackson Creek dam, 1.5 miles north of Jim Lott's land, near house occupied by Martin Avery (colored), at wire gate; iron post stamped "196 22 Prim. Trav. Sta. 31"	196.274
Lott's place, near Brown's schoolhouse, west side of road, spike in root of post oak tree; painted "238"	241.33
Four corners, northeast corner of road, 900 feet south of Brown's schoolhouse, spike in root of post oak tree; painted "211"	214.00
Graball, 1.5 miles south of, in front of Sam Grey's house, at west margin of road; iron post stamped "241 23 Prim. Trav. Sta. 32"	244.002
Three corners, 600 feet south of, east side of road, spike in root of pecan tree; painted "293"	295.85
Flat Prairie Church, 0.5 mile southeast of, east side of road, spike in root of elm tree; painted "174"	176.50
Brazos River, Lock No. 1, surface of water at upstream end of lock, Oct. 30, 1909	153.83
Brazos River, Hidalgo Falls, 400 feet east of Lock No. 1, 10 feet northeast of corner of office building; iron post stamped "190 30 Prim. Trav. Sta. 49A"	193.047
Brazos River, Lock No. 1, northwest corner post of old lock-tender's house, in post marked "U.S.B.M. 201.245"; spike (Corps of Engineers' bench mark)	193.97
Brazos River, Lock No. 1, 0.5 mile north of, 30 feet east of road, spike in root of pecan tree; painted "193 7"	195.78
Brazos River, Lock No. 1, 0.9 mile north of, east margin of road, spike in root of Spanish oak; painted "190 8"	192.64
Harrington switch, 100 feet south of railroad, 100 feet west of highway, spike in root of hackberry tree; painted "191 9"	193.22
Harrington switch, 0.5 mile west of, 20 feet north of railroad milepost 22, at fence line; iron post stamped "189 31 Prim. Trav. Sta. 50A"	192.524
Harrington switch, 2.5 miles west of, at milepost 20, north side of track, at fence line; iron post stamped "195 32 Prim. Trav. Sta. 51A"	198.236
Harrington switch, 3 miles west of, railroad bridge 2042, north side, east end; top of most easterly bolt in guard rail "198 13"	200.84
Allenfarm, 2,000 feet west of, 45 feet west of milepost 18, at fence line; iron post stamped "201 33 Prim. Trav. Sta. 52A"	204.227
Allenfarm, 2.5 miles west of, south side of railroad, at fence line; iron post stamped "199 34 Prim. Trav. Sta. 53A"	201.563
Allenfarm, 3 miles west of, at railroad bridge 2035½, east end, south side; top of bolt painted "204 18"	206.44
Sand pit north along highway along west side of river to point near Koppe farm bridge.	
Gulf, Colorado & Santa Fe Ry. bridge over Brazos River, downstream side, top of west pier; aluminum tablet stamped "203 35 Prim. Trav. Sta. 54A"	206.490
Gulf, Colorado & Santa Fe Ry. bridge, 0.5 mile west of, on road to stone quarry, 100 feet north of railroad track, spike in root of live oak; painted "205 19"	208.56
Lauderdale's rock crusher, 0.25 mile northwest of, east margin of road, spike in root of post oak; painted "205 20"	208.32

	Feet.
Flat Prairie Church, opposite, 6 feet east of gate, north side of road; iron post stamped "185 24 Prim. Trav. Sta. 33"	187.574
Graball-Washington road, 600 feet from, west side of road, spike in root of post oak tree; painted "200"	204.00
Graball, 1.6 miles north of, at three corners, east margin of road, spike in root of post oak; painted "225"	229.01
Graball, 2 miles north of, junction of Washington-Brenham roads, northwest corner of three corners, 10 feet from corner of fence; iron post stamped "270 25 Prim. Trav. Sta. 34"	273.810
Bridge over Rocky Creek, 100 feet north of, west margin of road, spike in root of locust tree; painted "240"	244.27
Old Washington, 1 mile south of, 125 feet south of three corners, west margin of road, spike in root of hackberry tree; painted "283"	286.17
Old Washington, at corner of road opposite store; iron post stamped "225 26 Prim. Trav. Sta. 35"	228.183
Old Washington, bridge over Brazos River, west pier, south end; aluminum tablet stamped "193 27 Prim. Trav. Sta. 36"	196.324

Washington north along highway along east side of Brazos River to Harrington, thence west along Gulf, Colorado & Santa Fe Ry. to sand pit.

Washington, bridge over Brazos River, south end east pier at top, marked "U △ S" (U. S. Army Engineers' elevation 201.26)	195.18
Washington, bridge over Brazos River, 0.5 mile northeast of, north margin of road, spike in root of pecan tree; painted "188 1"	190.85
Washington, bridge over Brazos River, 1.1 miles northeast of, north margin of road, spike in root of hackberry tree; painted "180 2"	183.45
Navasota River Bridge, 200 feet west of, at road leading up Brazos River, corner of fence; iron post stamped "185 28 Prim. Trav. Sta. 37"	188.174
Navasota River Bridge, 1.5 miles north of, 100 feet east of road, spike in root of pecan tree; painted "185 5"	187.87
Navasota River Bridge, 1.8 miles north of, 20 feet east end of bridge over slough; iron post stamped "187 29 Prim. Trav. Sta. 48A"	189.640
Navasota River Bridge, 2.2 miles north of, south margin of road, spike in root of elm tree; painted "186 6"	188.82
Lauderdale's quarry, 1 mile north of, west side of road, at three corners, spike in root of pecan tree; painted "195 21"	197.99
Lauderdale's quarry, 1.5 miles north of, 50 feet west of road, spike in root of pecan tree; painted "202 22"	205.25
Lauderdale's quarry, 2 miles north of, on Stone farm, west margin of road, at gate, 5 feet from gatepost; iron post stamped "204 36 Prim. Trav. Sta. 55A"	206.795
Stone farm, 2.5 miles north of, stone quarry, east side of road, spike in root of elm tree; painted "198 23"	201.39
Four corners, southwest corner of, 20 feet from corner, spike in root of ash tree; painted "200 25"	203.63
Lauderdale's quarry, 3.2 miles north of, border of Stone and Jackson farms, 5 feet west of gate; iron post stamped "205 37 Prim. Trav. Sta. 56A"	207.723
O. A. Seward's farm, south margin of road, 8 feet from gate, spike in root of pecan tree; painted "206 26"	209.29
O. A. Seward's farm, 0.5 mile north of house, east margin of road, spike in root of cottonwood tree; painted "209 27"	212.44

	Feet.
Nash place, 50 feet east of road, 10 feet east of crib, spike in root of pecan tree; painted "208 28"	211.03
Coulter place, east margin of road, spike in root of hackberry tree; painted "209 29"	211.92
Smith's gin, 350 feet west of, 5 feet north of gate; iron post stamped "209 38 Prim. Trav. Sta. 57A"	212.218
Smith's gin, 0.5 mile north of, 60 feet west of river bank, spike in root of willow tree; painted "211 29"	214.26
Smith's gin, 1.5 miles north of, 50 feet east of road, spike in root of stump; painted "214 31"	216.88
Smith's gin, 1.7 miles north of, southwest corner of three corners, side of road, spike in root of cottonwood tree; painted "214 32"	217.65
Smith's gin, 2.3 miles north of (Koppe farm), west side of road, 6 feet from culvert; iron post stamped "215 39 Prim. Trav. Sta. 58A"	217.982

Point 1.3 miles south of Cochran north along highways on west side of Brazos River to Houston & Texas Central R. R. bridge over river at Harmon switch, thence north along highways on east side of Brazos River to point 1.7 miles south of Courtney.

Cochran, in front of schoolhouse, on east side of road, nail in root of 12-inch oak; marked "177.4"	177.07
Cochran, 1.9 miles north of, north of old road, about 0.3 mile north of negro cabin, 600 feet south of branch, at end of lane, on edge of highland, nail in root of 18-inch oak; marked "184.6"	184.19
Cochran, 3 miles north of, on road to Chapel Hill, at northwest corner of Lew Brook's place, on west side of road, at angle from north to east, just after entering bottom, 50 feet south of large bayou; iron post stamped "151"	150.951
Cochran, 4.6 miles north of, on Chapel Hill road, at southwest corner of three corners, in front of Gus Turner's (negro) cabin; iron post stamped "157"	157.020
Houston & Texas Central R. R. bridge over Brazos River, 2.1 miles south of, on Mars Markup plantation, east of Chapel Hill road, in front of cabin occupied by Andrew Jackson (colored); iron post stamped "163"	162.301
Houston & Texas Central R. R. bridge, 1.25 miles south of, in field at south edge of road through field, near old levee, 600 feet west of negro cabin, nail in root of 18-inch pecan tree	159.43
Houston & Texas Central R. R. bridge over Brazos River, 0.8 mile west of Harmon, in top of east pier south side; aluminum tablet stamped "169 No. 17 Prim. Trav. Stat. 26"	171.814
Harmon, opposite station, spike in telegraph pole; marked "158" (Semper's bench mark)	161.41
Houston & Texas Central R. R., 0.7 mile north of railway, about 400 feet from timber to east and west, nail in root of 36-inch elm which stands alone in cotton field; marked "154.1"	156.81
Stone's gin, 1,500 feet southeast of, on Stone plantation, 6 feet north of road from house, on hill to east, 5 feet from gin house, 15 feet southeast of 30-inch pecan tree which stands alone in cotton field; iron post stamped "162 Prim. Trav. Sta. 38A"	164.172
Stone's gin, 0.6 mile northeast of, about 400 feet east of main timber line along river, in thicket, notch in root of western of two large dead trees; marked "160.9"	163.41

	Feet.
Stone's gin, 1.1 miles north of, on north side of large bayou, at edge of timber along bayou, about 300 feet north of main timber line along river; notch between forks of two forked elms, marked "163.3"	165.68
John Torrey's house, 200 feet northeast of, 150 feet south of stable, 100 feet southeast of 8-inch dead pecan tree, about 1.5 miles southwest of Wood's ginhouse; iron post stamped "175 Prim Trav. Sta. 39A"	177.657
John Torrey's house, 0.8 mile north of, 100 feet northeast of, mouth of ditch dug on cut-off, 5 feet east of river bank at north edge of timber; nail in root of 12-inch cottonwood tree, marked "167.1"	169.37
John Torrey's house, 1.1 miles northeast of, 75 feet south of field road through Loch Buchanan's bottom, 50 feet west of edge of cotton and corn fields, 15 feet west of 16-inch oak, which stands 500 feet east of thicket and is distinguishable as the only oak in field with leaves to top; iron post stamped "178 Prim. Trav. Sta. 40A"	180.633
Negro settlement on Loch Buchanan's plantation, in west side of quarters, just west of tank; nail in root of 26-inch oak, marked "208.7"	211.09
Wood's gin, 1 mile north of, at southwest corner of road to Clark's bottom and road through negro settlement; nail in root of 24-inch oak, marked "200.7"	203.95
Wood's gin, 2.3 miles northeast of, at south edge of Clark's bottom, 75 feet east along road to east at foot of lane, 0.2 mile north of John Marshall's house; iron post stamped "168 Prim. Trav. Sta. 41A"	171.659
Charles Thornton's cotton field, southwest corner of, about 0.8 mile southwest of house, 200 feet from west timber line, 1,000 feet from south timber line; nail in root of 24-inch pecan tree, marked "166.2"	169.23
Charles Thornton's house, in foot of brick pier under porch at southeast corner; cross cut on brick marked "171.3"	173.36
Charles Thornton's house, 0.8 mile northeast of, 400 feet south of cabin, 10 feet south of two large pecan trees which stand along in field about 75 feet east of road; iron post stamped "173 Prim. Trav. Sta. 42A"	175.230
Charles Thornton's house, 1.6 miles northeast of, 150 feet back of gate at fence corner, at corner of old field, cotton field and timber, on east side of road to railroad; nail in root of 12-inch hackberry tree, marked "173.9"	175.90
Courtney, 2.5 miles south of, 100 feet north of milepost 60, 300 feet north of Grimes-Waller county line post, at northwest corner of road crossing with Houston & Texas Central R. R.; iron post stamped "192 Prim. Trav. Sta. 43A"	194.072
Courtney, 1.7 miles south of, bridge "61A" on Houston & Texas Central R. R., west wing wall of south abutment, in stone 30 inches from south end, 8 inches from west edge; chiseled cross in circle, marked "180.5"	182.21
Courtney, on Houston & Texas Central R. R., at foot of principal street, 75 feet east of south end of station, at corner of fence; iron post stamped "185 Prim. Trav. Sta. 44A" (as reset)	185.121

Courtney north along Houston & Texas Central R. R. and public roads up the east side of Brazos River to Navasota.

	Feet.
Courtney, 2.5 miles north of, 50 feet west of Houston & Texas Central R. R. track, at road crossing, 0.2 mile north of negro cabin; iron post stamped "181 Prim. Trav. Sta. 45A"	181.723
Courtney, 4.6 miles north of, on west end of southernmost transverse girder in bridge of Houston & Texas Central R. R. over Walkers Creek; chiseled cross marked "188.2"	189.08
Walkers Creek, 0.9 mile northwest of Houston & Texas Central R. R. bridge over, on Wilson's plantation, 1,200 feet north of road leading from railway to plantation house, about 0.5 mile west of railway, 15 feet west of 24-inch oak which stands alone in small tongue of highland; iron post stamped "197 Prim. Trav. Sta. 46A"	198.112
Barron's plantation, 75 feet south of house, distinguishable by a white stone chimney to south, copper nail in root of 36-inch oak; marked "189.4"	189.92
Barron's house, 900 feet north of, on east side of road to gin, opposite newly built negro cabin, copper nail in root of 12-inch elm tree; marked "188.4"	188.81
Wilson's gin, 0.4 mile northwest of, 600 feet north of road to bottom, 6 feet east of north-south fence between cotton fields at edge of bottom; iron post stamped "189 Prim. Trav. Sta. 47A"	189.076
Navasota, 0.3 mile west of, at west end of wagon bridge over Navasota River; iron post stamped "185 Prim. Trav. Sta. 37"	188.174

Old Washington northwest along roads up west side of Brazos River to Gulf, Colorado & Santa Fe Ry. bridge at sand pit.

Old Washington, on road bridge over Brazos River; tablet stamped "193 Prim. Trav. Sta. 36"	196.324
Old Washington, 0.8 mile northwest of, on east side of road to Clay station, at E. C. Currey's house, 400 feet south of T road west, copper nail in root of 20-inch oak tree; marked "236.4"	233.41
Old Washington, 1.6 miles northwest of, on east side of road to Clay, 300 feet south of gate across road through Moore's place, nail in root of 30-inch oak tree; marked "U.S.T.B.M. 192.1"	189.13
H. M. Moor's house, 0.7 mile south of, at junction of Y lane, east to house, nail in 12-inch oak tree; marked "262.3"	259.31
H. M. Moor's place, 0.5 mile north of cross lane along lane that leads from Moor's house north to Washington-Independence road, east of road on small summit, at vacant shanty, about 1.3 miles southwest of Moor's house; iron post stamped "286 Prim. Trav. Sta. 96A"	283.270
Charlie Bruloor's house, 300 feet south of, 15 feet from road, at angles from east to north, in sandstone slab from ledge north of road, 2-inch square hole chiseled in outline; center of hole; stone marked "302.44"	299.46
St. Matthew's Church (negro), 0.5 mile southeast of, 40 feet south of angle in road from north to west, nail in root of 20-inch oak tree; marked "341.2"	337.28
St. Matthew's Church, 300 feet west of, west of road; iron post stamped "351 Prim. Trav. Sta. 97A"	346.939
St. Matthew's Church, 0.8 mile northwest of, in bottom 175 feet north of first bayou north of church, 300 feet west of thicket along river, in center of field, nail in root of 36-inch pear tree; marked "207.3"	203.33

	Feet.
St. Matthew's Church, 1.8 miles west of, 300 feet south of river, 100 feet west of second bayou north of church, in cottonfield, where bayou turns northwest, nail in 12-inch stump cut 1 foot high; marked "209.7"	205.79
Rockling's place, 0.5 mile northeast of house in cornfield where river makes sharp angle from west to south, 300 feet east of one side of angle and 1,000 feet south of other side, 5 feet north of 26-inch dead pin-oak tree, 300 feet southwest of large dead limbless tree; iron post stamped "218 Prim. Trav. Sta. 98A"	213.715
Rockling's place, 1 mile northeast of, at edge of river in woods, nail in root of 12-inch elm tree; marked "205.3"	201.35
North bank of large creek, 400 feet from its mouth, at south end of clearing used for hog pasture; iron post stamped "205 Prim. Trav. Sta. 99 A" (as reset)	199.528
Yegua River, 0.25 mile south of mouth of, on east side of river, nail in root of 30-inch oak tree at edge of river at boat crossing; marked "205.7"	201.71
Sand pit, on downstream end of west pier of Gulf Colorado & Santa Fe Railway bridge; aluminum tablet stamped "210"	206.490

Sand pit north along International & Great Northern R. R. up east side of Brazos River to Enright.

Clays farm, 0.9 mile south of house, 1,800 feet south of cabin, in field, 400 feet east of levee; at large pecan tree which stands alone in field; iron post stamped "No. 11 Prim. Trav. Sta. 95A" (reset value)	206.720
Clays farm, 0.8 mile east of house, 0.6 mile south of section house, 50 feet west of railroad, north of dirt road at crossing; iron post stamped "No. 10 Prim. Trav. Sta. 94A"	234.060

BRYAN QUADRANGLE.

Koppe farm bridge northwest along west side of Brazos River to Pittbridge.

Koppe farm, bridge over Brazos River, west abutment, top, on downstream side; chiseled square marked "221 34"	224.68
Koppe farm, 0.2 mile east of, 160 feet south of road, spike in root of Spanish oak; painted "213 35"	216.04
Koppe farm, 300 feet north of, 20 feet north of culvert over drainage ditch, 400 feet east of cotton gin; iron post stamped "214 40 Prim. Trav. Sta. 59A"	216.921
Koppe farm, 0.5 mile north of, 40 feet west of fork of road, at south margin of roads, spike in root of stump; painted "214 36"	217.19
Koppe farm, 1 mile north of, north end of downstream side of bridge, spike in guard rail; painted "213 37"	216.22
Chance's store, 60 feet south of, west side of road, 8 feet from gatepost; iron post stamped "218 41 Prim. Trav. Sta. 60A"	220.813
Chance's store, 0.2 mile north of, west side of road, spike in tree root; marked "39"	219.37
Chance's store, 1 mile north of, 350 feet west of Whites Chapel, west margin of road, spike in root of elm; painted "221 40"	224.45
Whites Chapel, 0.5 mile north of, west side of road, spike in root of Spanish oak; painted "222 41"	225.46
Whites Chapel, 1 mile north of, east side of road, spike in root of Spanish oak; painted "222 42"	225.44

	Feet.
Robinson's place, 300 feet west of house, southwest corner of road, 80 feet west of barn; iron post stamped "221 42 Prim. Trav. Sta. 61A"	224.370
Robinson's place, 1 mile north of, 10 feet east of gate, margin of road, spike in root of ash tree; painted "220 44"	223.41
Jones Bridge over Brazos River, west side, downstream, top of pier; aluminum tablet stamped "228 43 Prim. Trav. Sta. 62A"	230.945
Jones Bridge over Brazos River, east end, upstream side, top of pier (U. S. Army Engineers' bench mark; no mark)	233.22
Wooden bridge over branch, 15 feet south of, east side of road, spike in root of pecan tree; painted "219 46"	222.05
Butler's cotton gin, 0.2 mile south of, 50 feet southeast of road; spike in root of pecan tree, painted "223 48"	225.89
Butler's place, southwest corner of yard; iron post stamped "225 44 Prim. Trav. Sta. 63A"	227.809
Butler's place, 0.5 mile north of, west margin of road; spike in root of elm tree, painted "220 49"	222.85
Butler's place, 1 mile north of, west margin of road; spike in elm tree, painted "219 50"	222.11
Butler's place, 1.7 miles north of, west margin of road; spike in root of elm tree, painted "226 51"	228.86
Butler's place, 2 miles north of, 100 feet west of culvert, opposite corner of pasture, north margin of road; iron post stamped "224 45 Prim. Trav. Sta. 64A"	227.434
Butler's place, 2.5 miles north of, 90 feet north of offset in road, west margin of road; spike in root of pecan tree, painted "228 52"	231.05
Pittbridge, 1.6 miles south of, west margin of road; spike in root of ash tree, painted "231 53"	233.92
Bayou Bridge, 150 feet north of, east margin of road; spike in root of elm tree, painted "230 54"	233.06

Enright northwest by highway along railroad to Pittbridge.

Enright, 0.4 mile north of, east of track, south of road at crossing; iron post stamped "No. 9 Prim. Trav. Sta. 93A"	287.282
Rayder, 0.8 mile south of, 400 feet north of sign "Enright 1 mile," in west longitudinal girder over bridge 128; top of north bolt, marked "No. 21"	293.95
Wilkins, 1.1 miles west of, on east side of road to Koppe's bridge, at top of small summit, 3 feet west of wire fence; iron post stamped "No. 8 Prim. Trav. Sta. 92A"	286.294
Koppe's Bridge, 1 mile north of, on north side of road through cotton field, 0.4 mile west of cabin, at three large elm trees; iron post stamped "No. 71 Prim. Trav. Sta. 91A"	216.190
Whites Creek, 1.25 miles south of, 900 feet southeast of brick chimney of burned dwelling on point of high land about 200 feet from river, about 600 feet from river; nail in root of 12-inch pecan tree which stands between two small sloughs, marked "No. 13"	228.46
Whites Creek, 0.4 mile south of, on east edge of small bayou that runs between cotton field and scattered timber, 500 feet from river bank; iron post stamped "No. 6 Prim. Trav. Sta. 90 A"	218,910
Whites Creek, 1,200 feet north of, on east edge of bayou, 100 feet from river bank; nail in root of two-pronged pecan tree; temporary bench mark; marked "No. 12"	218.85

	Feet.
Jones Bridge, 3 miles east of, 150 feet northwest of river, on north edge of small slough, nail in 12-inch pecan tree, about 1 foot above ground, temporary bench mark; marked "No. 11"	222.53
Jones Bridge, 2.1 miles east of, on west bank of Bushy Creek, 1,000 feet north of river, 1,000 feet southeast of negro cabin on bare hill; iron post stamped "No. 5 Prim. Trav. Sta. 89 A"	221.498
Jones Bridge, 1.6 miles east of, 450 feet east of fence directly across river from Robinson's place; nail in root of 36-inch elm which stands alone; temporary bench mark; marked "No. 10"	221.41
Jones Bridge, 1 mile east of, in old cornfield, 600 feet north of small bayou, 50 feet west of timber along hill; nail in root of 28-inch pecan tree; temporary bench mark; marked "No. 9"	223.77
Jones Bridge, in south side of west pier, in top; aluminum tablet stamped "43 228 Prim. Trav. Sta. 62 A"	230.945
Jones Bridge, 1.4 miles west of, about 800 feet east of river, south edge of old field, north edge of small bayou, nail in root of small three-pronged blackjack; temporary bench mark; marked "No. 8"	234.28
Jules Koppe's house, 3.3 miles south of, at north edge of strip of timber between two fields, about 200 feet west of southeast corner of north field, 600 feet east of river, 0.5 mile north of Thompson's Creek, nail in 12-inch elm about 3 feet above ground; temporary bench mark; marked "No. 7"	228.97
Jules Koppe's house, 2.6 miles south of, south side of lane at gate to wood road which runs along edge of small field; iron post stamped "Prim. Trav. Sta. 88 A"	226.485
Jules Koppe's house, 0.8 mile south of, on west side of road, just south of bayou crossing, nail in 12-inch willow; temporary bench mark; marked "No. 5"	227.56
Jules Koppe's place, 700 feet southwest of John Zullkowsky's house, in front of negro cabin, at northeast corner of T road; iron post stamped "Prim. Trav. Sta. 87 A"	244.881
Jules Koppe's place, 0.5 mile north of, west of road; nail in root of 12-inch hackberry tree	243.82
Pittbridge, 2.5 miles southeast of, at T road; nail in root of 36-inch oak tree	261.13
Pittbridge, 1.8 miles east of, on west side of north-south road to Stone City, at T road to Bryan, in front of church building; iron post stamped "Prim. Trav. Sta. 86 A"	264.600
Pittbridge, in steel plate at top of west steel pier on north side of bridge; chiseled square in outline	242.85
Little Brazos Bridge, 1.2 miles east of, White church at T roads, at northwest corner; nail in 24-inch hackberry tree	242.92

HEARNE QUADRANGLE.

Point 2 miles east of Pittbridge north along public roads up east side of Brazos River to Stone City.

Bridge over Little Brazos River, 0.6 mile east of, along road to Bryan, north of road at cabin; nail in root of 24-inch oak	245.67
Bridge over Little Brazos River, west end of, about 1.5 miles southeast of Stone City, south of road; iron post stamped "Prim. Trav. Sta. 85A"	232.680
Stone City, opposite post office; nail in root of elm tree; marked "239"	242.72

Marleys Ferry (Stone City) north along roads up west side of Brazos River to point 2 miles south of Sixmile Bridge.

	Feet.
Marleys Ferry, 800 feet west of, near store; iron post stamped "262"	265.617
Marleys Ferry, 1.8 miles north of, 100 feet from river, nail in 12-inch elm in old slough that runs along river; marked "235 2"	233.83
Marleys Ferry, 2.3 miles north of, at north edge of clearing, 400 feet from river, near fence line; iron post stamped "251 Prim. Trav. Sta. 84A"	250.653
Cedar Creek, 0.4 mile south of, Hiram Wilson's (colored) place, 600 feet south of large bayou about 200 feet from river, nail in 17-inch walnut; marked "246.6"	245.21
Cedar Creek, 0.4 mile east of, at south edge of thicket, about 400 feet east of dilapidated cabin in cotton field, nail in 36-inch pecan tree; marked "243.55"	242.11
George Washington's (colored) place, about 2,000 feet east of house, in field at foot of road to bottom, 15 feet west of ditch through field, near two pecan trees which stand close together; iron post stamped "247 Prim. Trav. Sta. 83A"	245.079
Jackson's plantation, west end of, at east edge of thicket about 300 feet from river, nail in root of 18-inch wild chinaberry tree; marked "249.9"	248.42
Jacksons' plantation, 1,200 feet north of cabin occupied by Dave Washington (colored), at south edge of timber, nail in 9-inch oak; marked "286.23"	284.76
Jim Moor's plantation, about 0.5 mile southeast of house, 1,200 feet west of cabin, in cotton field, nail in 12-inch pecan; marked "289.4"	287.97
Jim Moor's plantation, on east edge of, 300 feet west of strip of timber along Damm Branch, nail in 12-inch oak; marked "266.9"	265.38
Three corners, south side of road at, 500 feet west of negro cabin, near large oak; iron post stamped "271.8"	270.29
Craig's place, directly east about 70 feet from house occupied by Williams, nail in root of 18-inch oak which leans toward house; marked "279.2"	277.71
Rita, 1.5 miles northeast of, at east edge of timber, in bottom, 0.4 mile south of old cabin which stands on small knoll; iron post stamped "258"	256.091
Y road, 250 feet north of, near river, on east side of old road, 10-penny nail in 20-inch oak; marked "279.6"	278.18

Pittbridge north along highway along west side of river to Moseleys Ferry.

Pittbridge, 0.5 mile west of, southwest corner of three corners, 3 feet from fence corner; iron post stamped "231 46 Prim. Trav. Sta. 65A"	234.864
Pittbridge, 1.5 miles west of, south margin of road, spike in root of pecan tree; painted "233.56"	235.84
Parker's store, 1,000 feet north of, at gate leading into field, north margin of road; iron post stamped "243 47 Prim. Trav. Sta. 66A"	245.816
Parker's store, 1 mile north of, 100 feet west of road, at turn to east, spike in root of bois d'arc tree; painted "243 58"	245.87
Moseleys Ferry, 0.3 miles south of, north margin of road, spike in root of hackberry tree; painted "253 59"	256.61
Moseleys Ferry, 600 feet south of, 30 feet east of Sam Wilson's store; iron post stamped "262 48 Prim. Trav. Sta. 67A"	265.617

Moseleys Ferry north along east side of river along Hearne & Brazos Valley R. R. and International & Great Northern R. R.

	Feet.
Moseleys Ferry, 600 feet east of, 100 feet east of Stone City post office, spike in root of elm tree; painted "239 60"	242.72
Moseleys Ferry, 0.5 mile north of, 100 feet west of railroad, spike in root of pecan tree; painted "239 61"	242.32
Stone City, 1 mile north of, 50 feet west of railroad, spike in root of pecan tree; painted "245 62"	248.14
Mills, 930 feet north of, 10 feet west of track, on north side of railroad crossing; iron post stamped "241 49 Prim. Trav. Sta. 68A"	244.500
Mills, 0.7 mile north of, 15 feet east of railroad, spike in root of cottonwood tree; painted "241 63"	244.00
Mills, 1.1 miles west of, 110 feet west of railroad, spike in root of pecan tree; painted "245 64"	248.46
Steel's store, 0.2 mile south of, 150 feet south of railroad crossing, spike in root of hackberry tree; painted "244 65"	247.49
Steel's store, railroad crossing at freight platform, 20 feet east of track, at fence corner; iron post stamped "245 50 Prim. Trav. Sta. 69A"	248.900
Steel's store, 1 mile north of, 20 feet west of track, spike in root of pecan tree; painted "248 67"	251.88
Steele's store, 1.5 miles north of, 80 feet west of railroad track, spike in root of cottonwood tree; painted "252 68"	255.73
Ashton's gin, 200 feet north of, at road crossing, 6 feet west of track; iron post stamped "251 51 Prim. Trav. Sta. 70A"	254.660
Ashton's gin, 0.5 mile north of, 120 feet west of track, spike in root of cottonwood tree; painted "249 69"	252.26
Mumford, 0.7 mile south of, 50 feet west of track, spike in root of elm tree; painted "246 70"	249.76
Mumford, 0.2 mile north of, opposite water tank, between tracks of Hearne & Brazos Valley and International & Great Northern R. Rs.; iron post stamped "254 52 Prim. Trav. Sta. 71A"	257.737
Olinda switch, opposite railroad crossing of Hearne & Brazos Valley and International & Great Northern R. Rs. tracks; iron post stamped "260 53 Prim. Trav. Sta. 72A"	263.411
Tatsie switch, on International & Great Northern R. R., 330 feet south of junction of railroads, 4 feet south of station sign, between tracks; iron post stamped "261 54 Prim. Trav. Sta. 73A"	264.595
Valley Junction, 1.5 miles south of, 6 feet west of milepost 99, on International & Great Northern R. R.; iron post stamped "261 55 Prim. Trav. Sta. 74A"	264.944
Valley Junction, 0.8 mile south of, 80 feet north of track, opposite crossing, spike in root of elm tree; painted "265 82"	268.15
Valley Junction, 45 feet east of station, 30 feet south of east and west track; iron post stamped "274 56 Prim. Trav. Sta. 75A"	277.422

Valley Junction north along International & Great Northern R. R. (east side of river) to milepost 114.

Valley Junction, 2,200 feet northwest of, 40 feet south of track, spike in base of milepost 101; painted "270 84"	273.51
Valley Junction, 1.5 miles north of, 50 feet south of track, spike in base of milepost 102; painted "266 86"	269.67

	Feet.
Valley Junction, 2.2 miles north of, 150 feet south of milepost 103, 20 feet east of track, at corner of wire fence, opposite road crossing; iron post stamped "Prim. Trav. Sta. No. 76 A 275 57"	278.260
Valley Junction, 4.4 miles north of, 10 feet west of track, opposite milepost 105; iron post stamped "277 58 Prim. Trav. Sta. No. 100 A"	280.690
Milepost 106, 50 feet south of track, spike in foot of; painted "276 92"	279.65
Marriam station, opposite seed house, north side of track, 5 feet south of station sign; iron post stamped "Prim. Trav. Sta. No. 101 A 282 59"	285.291
Milepost 109, 5 feet north of, 30 feet west of road; iron post stamped "Prim. Trav. Sta. No. 102 A 283 60"	286.218
Milepost 110, in first telegraph pole south of; spike painted "286 98"	289.81
Milepost 111, directly west of post, at fence post; iron post stamped "Prim. Trav. Sta. No. 103 A 290 61"	293.728
Milepost 112; spike painted "294 101"	297.43
Milepost 113, 30 feet west of track, 2 feet south of post; iron post stamped "295 62 PRIM. TRAV. STA. 104 A"	298.179
Milepost 114, in first telegraph pole south of; spike painted "297 104"	300.67

Sixmile Bridge north along west side of river to point near Valley Junction.[1]

Sixmile Bridge, 1.4 miles southeast of, west of road, 300 feet south of clearing where road turns east, in 12-inch oak tree; 10-penny nail	304.12
Sixmile Bridge, 0.8 mile southeast of, 600 feet south of negro's cabin, in pasture, 50 feet west of road through woods, in 30-inch oak; 10-penny nail	301.28
Sixmile Bridge, 50 feet from north end of, 10 feet east of road from Stone City to Gause; iron post stamped "Prim. Trav. Sta. No. 80 A 264"	261.996
Sixmile Bridge, 0.5 mile northwest of, on west side of road, in root of 12-inch oak tree; 10-penny nail	283.44
Sixmile Bridge, 1.1 miles northwest of, 0.6 mile north of public road, on east side of creek, 200 feet south of junction with creek, to south, in notch in small tree; 10-penny nail	284.30
Sixmile Creek, 1.5 miles south of, at southwest corner of clearing, 1,100 feet southeast of dwelling, 50 feet north of county road, to river, 200 feet east of small wooden bridge, near gap, in 18-inch white oak; nail marked "321.9"	319.82
Twomile Creek, 1,000 feet south of, nail in 36-inch pecan tree which stands alone in bottom; marked "263.7"	261.43
Brown's farm, 800 feet southeast of house occupied by Williams, at edge of cotton field, in small pasture, at summit of tongue of highland, running toward river; iron post stamped "Prim. Trav. Sta. 79 A 311"	308.218
Brown's farm, north edge of, 500 feet south of timber, nail in 12-inch pecan tree which stands alone in field; marked "265.8"	263.39
International & Great Northern R. R. bridge over Brazos River, 2.1 miles southeast of, nail in root of large pecan slanting toward hill at south edge of clearing, 300 feet north of edge of thicket; marked "270.7"	268.20

[1] A gross error of 1 foot has been adjusted in this line.

	Feet.
International & Great Northern R. R. bridge over Brazos River, 1.5 miles southeast of, about 800 feet north of large bayou, 300 feet west of cabin on hill, 300 feet south of timber at; 28-inch oak tree; iron post stamped "Prim. Trav. Sta. No. 78–A 299.48"	296.920
International & Great Northern R. R. bridge, 0.9 mile southeast of nail in root of 36-inch oak on Frank Thomas's place, near fence at north edge of cotton field, about 800 feet southwest of house; marked "302.8"	300.19
International & Great Northern R. R. bridge, 0.5 mile southeast of, on small ridge, nail in root of 14-inch pecan tree	305.05

Valley Junction west along International & Great Northern R. R. 1.7 miles, thence north to Port Sullivan.

Valley Junction, at southeast corner of crossing of International & Great Northern R. R., iron post stamped "Prim. Trav. Sta. 75 A 274"	277.422
Valley Junction, 1.7 miles west of, top of south end of western concrete retaining wall for bridge "95 C" on International & Great Northern R. R.; aluminum tablet stamped "Prim. Trav. Sta. No. 77 A 288"	285.068
Little River, 0.2 mile south of, 0.3 mile from mouth on bank of timbered slough 300 feet wide, which bears S. 60 degrees W. of open field on south of post and north of slough; iron post stamped "Prim. Trav. Sta. No. 25 TEXAS 1910 273"	270.328
Port Sullivan, about 0.6 mile west of, Brazos River bridge, on land of Mr. Harbon, at south fence, lane of private road opposite small shanty, in clump of trees; iron post stamped "Prim. Trav. Sta. No. 1"	301.080

Port Sullivan north along west side of river to Wildcat Bridge and across river to milepost 109.

Port Sullivan, 1,500 feet north of post office, 300 feet south of house, copper nail in large oak tree on river bank	283.66
Port Sullivan, 0.8 mile north of, copper nail in pecan tree 500 feet from river bank in open field	276.00
Port Sullivan, 1.4 miles north of, in open field, 2 feet north of wire fence, 225 feet from river, on land owned by John Livingston (colored); iron post stamped "Prim. Trav. Sta. No. 26 TEXAS 1910 281"	280.457
Port Sullivan, 2 miles north of, in open field and 300 feet west of timber; nail in pecan tree	281.43
Port Sullivan, 2.3 miles north of, on knoll among scattering timber, copper nail in hackberry tree	304.70
Wildcat Bridge, 3 miles south of, 550 feet south of bank of Brazos River, on sloping ground at edge of timber line; iron post stamped "Prim. Trav. Sta. No. 27, TEXAS 1910 311"	311.047
Wildcat Bridge, 2 miles south of, copper nail in large pecan tree in open field	284.56
Wildcat Bridge, 0.9 mile south of, about 0.5 mile west of river bank, at edge of timber, 5 feet south of wire fence, on land owned by Mr. Martin; iron post stamped "Prim. Trav. Sta. No. 28 TEXAS 1910 322"	322.471

	Feet.
Wildcat Bridge, 0.5 mile south of, in open field, 300 feet west of river, 300 feet from wooded rising ground, copper nail in root of pecan tree; painted "U.S.B.M. 293"	293.04
Wildcat Bridge, 8 feet from southeast corner of, in top of concrete wing wall; aluminum tablet stamped "Prim. Trav. Sta. No. 29 288"	287.438
Calvert Junction, about 1 mile south of, 5 feet north of milepost 109, 30 feet west of railroad; iron post stamped "Prim. Trav. Sta. No. 102 A"	286.218

Wildcat Bridge north along west side of river to Black Bridge and across river to milepost 113.

Wildcat Bridge, 0.5 mile north of, 800 feet west of river; copper nail in root of small pecan tree in grade in cultivated field; painted "U.S.B.M. 291"	290.59
Wildcat Bridge, 1 mile north of, in cultivated field, about 600 feet west of river, copper nail in root of pecan tree; painted "U.S.B.M. 286"	286.42
Wildcat Bridge, 1.5 miles northwest of, in open field about 400 feet west of river bank; copper nail in root of brushy cedar tree; painted "U.S.B.M.P.T. Sta. 85"	296.31
Wildcat Bridge, 2 miles north of, opposite Calvert coal mine on other side of river, at edge of timber and open field, 2,000 feet west of river; iron post stamped "Prim. Trav. Sta. No. 30 308"	308.108
Wildcat Bridge, 2.5 miles north of, 100 feet southeast of dry ravine, nail in root of hackberry tree on bank of river; painted "No. 19 P.T. 92"	290.16
Wildcat Bridge, 3.2 miles north of, 300 feet west of river, at fence line between open fields; copper nail in root of small pecan tree	297.41
Black Bridge, 1.2 miles south of, copper nail in oak tree on river bank at edge of timber	305.54
Black Bridge, 0.5 mile west of Calvert, in top, north side of west pier; aluminum tablet stamped "Prim. Trav. Sta. No. 31 300"	299.481

Valley Junction up Little River to point 3.6 miles southwest of Cameron.

Valley Junction, 2.2 miles north of, 30 feet east of International & Great Northern R. R. track, 900 feet south of public road crossing, 200 feet south of milepost 103; iron post stamped "275"	278.260
International & Great Northern R. R., 1 mile west of, north margin of public road, opposite negro house, copper nail in root of bois d'arc tree; painted "276"	275.425
Port Sullivan, 50 feet east of east end of Brazos River bridge, south side of road, copper nail in root of pecan tree; painted "277 No. 2"	276.28
Port Sullivan, about 0.6 mile west of Brazos River bridge, on land belonging to Mr. Harlan, at south fence line of private road opposite small shanty, in clump of trees; iron post stamped "Prim. Trav. Sta. No. 1 302"	301.080
Port Sullivan, 1.1 miles west of, 150 feet east of farm road, on bench above flood plain, copper nail in root of pecan tree in open field; painted "289 No. 3"	289.01
Port Sullivan, 1.8 miles west of, 600 feet east of negro house, copper nail in root of hackberry tree in brushy fence line; painted "285 No. 4"	284.81

	Feet.
Port Sullivan, 2.1 miles west of, 50 feet south of fence line, 200 feet west of negro house on Mr. Harlan's land, just close to edge of flood plain, copper nail in root of oak tree; painted "288 No. 5"	287.70
Port Sullivan, 2.6 miles west of, 150 feet northwest of fence line and vacant shanty, copper nail in root of post oak tree in pasture; painted "287 No. 6"	286.10
Port Sullivan, 2.8 miles west of, on land of Rufus Smith, in wooded pasture, bench above flood plain, 75 feet south of gate, 350 feet south of house, 15 feet northeast of painted post oak tree; iron post stamped "Prim. Trav. Sta. No. 2 291"	290.359
Port Sullivan, 3.2 miles west of, on land of Rufus Smith, in wooded pasture, about 200 feet west of negro house, 100 feet east of wire fence, copper nail in root of blackjack oak; painted "287 No. 7"	286.494
Port Sullivan, 3.7 miles west of, farm road leading west, in flood plain, 100 feet west of gate, in fence line on north side of road, copper nail in root of pecan tree; painted "277 No. 8"	276.54
Port Sullivan, 4.1 miles west of, dead trees around, copper nail in root of pecan tree in field; painted "278 No. 9"	277.12
Port Sullivan, 4.5 miles west of, 0.5 mile east of public road leading across Little River, copper nail in root of lone large pecan tree in open field; painted "279 No. 10"	278.74
Cliff Tyson's house, 0.5 mile south of, public road crossing Little River, west side of road, 5 feet inside of wire fence and 5 feet from a corner fence post, negro house across road; iron post stamped "Prim. Trav. Sta. No. 3 281"	280.053
Tyson's house, 0.9 mile southwest of, public road crossing Little River, 0.4 mile west of, 75 feet east of deep slough, copper nail in root of pecan tree (one of group); painted "283 No. 11"	282.60
Tyson's house, 1.4 miles southwest of, 0.5 mile west of deep slough, copper nail in root of lone pecan tree in field; painted "283 No. 12"	282.94
Tyson's house, 2.3 miles southwest of, vacant shanty near bank of Little River, about 100 feet west by 100 feet south of well, at fence line, copper nail in root of pecan tree; painted "286 No. 13"	285.68
Tyson's house, 2.8 miles southwest of, about 200 feet east of Little River, in open field, copper nail in root of large mulberry tree; painted "296 No. 14"	295.78
Cameron, 16.9 miles east of, in timbered pasture, at fence line, 10 feet west of a gate, 55 feet east of slough; iron post stamped "Prim. Trav. Sta. No. 4 298"	297.185
Cameron, 16.3 miles east of, in partly cleared bottom land, brush and woods on south, cleared on north, just south of farm roadway, copper nail in root of elm tree; painted "288 No. 15"	287.62
Cameron, 16.1 miles east of, large cotton field on south and west, brush and timber on northeast, at right-angle corner of timber, edge of farm road, copper nail in root of pecan tree; painted "287 No. 16"	286.98
Cameron, 15.3 miles east of, in brush and wooded area partly cleared, 100 feet west of wire fence, copper nail in root of elm tree; painted "288 17"	287.92
Cameron, 14.8 miles east of, at south edge of drainage ditch, copper nail in root of lone elm tree; painted "287 No. 18"	286.52
Cameron, 14.4 miles east of, on sandy knoll about 20 feet higher than bottom lands and extending out into bottoms, 10 feet north of walnut tree, 90 feet east of negro house; iron post stamped "Prim. Trav. Sta. No. 5 307"	308.518

	Feet.
Cameron, 13.6 miles east of, in edge of woods, 90 feet west of fence line and 25 feet south of fence line, open fields east and north, copper nail in root of large cottonwood tree; painted "292 No. 19"	291.02
Cameron, 13.3 miles east of, 36 feet west of wire fence, in small grove between open fields, copper nail in root of 15-inch elm tree; painted "293 No. 20"	292.66
Cameron, 12.6 miles east of, in open field, 2,000 feet south of house with windmill on bluff, 400 feet west of fence line, copper nail in root of large lone persimmon tree 30 inches in diameter; painted "296 No. 21"	295.33
Cameron, 12.2 miles east of, at fence line between two pastures, 8 feet east of 20-inch sycamore tree, about 1,000 feet south of low fringe of hills, about 2,000 feet southwest of house with windmill, 350 feet east of water course; iron post stamped "Prim Trav. Sta. No. 6 299"	298.649
Cameron, 11.4 miles east of, copper nail in root of large lone pecan tree in field; painted "301 No. 22"	300.90
Cameron, 10.4 miles east of, at edge of hill and 90 feet north of Little River, copper nail in root of 24-inch oak tree; painted "307 No. 23"	306.71
Cameron, 10.1 miles east of, on bench land 30 feet above bottom lands, scattering timber and mesquite bushes, 1,000 feet east of bottom land, copper nail in root of leaning mesquite bush near primary traverse station No. 59; painted "333 No. 24"	332.30
Cameron, 9.6 miles east of, just above edge of bottom lands, in timbered pasture, copper nail in root of 20-inch oak tree; painted "309 No. 25"	308.98
Cameron, 9.1 miles east of, about 12 feet above bottom land, at fence line, 15 feet east of lone elm tree, 400 feet south of house occupied by a Mr. Henson, at wire gate; iron post stamped "Prim Trav. Sta. No. 7 311"	310.135
Cameron, 8.5 miles east of, about 500 feet west of a house, copper nail in root of lone elm tree at fence line between two pastures; painted "318 No. 26"	317.39
Cameron, 7.8 miles east of, at edge of woods and bottom lands, 100 feet north of a well and 300 feet from a house, copper nail in root of pecan tree; painted "319 No. 27"	318.49
Cameron, 7.3 miles east of, in strip of timber, 60 feet west of stream from north, copper nail in root of 24-inch pecan tree; painted "313 No. 28"	312.92
Cameron, 6.8 miles east of, on south side of creek, in strip of timber 1,000 feet wide, copper nail in root of 15-inch elm tree; painted "305 29"	304.19
Cameron, 5.9 miles east of, on south margin of east-west road, 10 feet east of an elm tree 15 inches in diameter, blazed and marked, 50 feet east of boundary fence between pasture and open field; iron post stamped "Prim. Trav. Sta. No. 8 306"	305.605
Cameron, 5.6 miles east of, 8 feet east of north-south wire fence, edge of woods, open land toward river, copper nail in root of double elm tree; painted "306 No. 30"	305.65
Cameron, 5 miles east of, edge of woods running north-south, at fence line, copper nail in root of elm tree; painted "309 No. 31"	308.06

	Feet.
Cameron, 4.5 miles east of, Cameron-Hearne highway at crossing of Elm Creek, under elm tree, 4 feet west of same, 25 feet west of bank of creek, 225 feet north of northeast corner of bridge; iron post stamped "Prim. Trav. Sta. No. 9 308"	307.280
Cameron, 3.9 miles east of, west side of edge of timber and cultivated land, 4 feet east of wire fence, 1,200 feet west of house on hill, copper nail in root of elm tree on Elm Creek; painted "310 No. 32"	309.63
Cameron, 3.2 miles east of, west side of Elm Creek, 50 feet north of fence line and 500 feet south of small creek, copper nail in root of elm tree; painted "307 No. 33"	306.58
Cameron, 2.5 miles east of, on narrow point of land running out into bottom lands, 100 feet west of Little River, 55 feet southeast of W. K. Hawkins's house, copper nail in root of oak tree in barnyard; painted "328 No. 34"	327.48
Cameron, 1.9 miles east of, on bench land about 40 feet above river bottom and 150 feet north of, at wire fence line, copper nail in root of hackberry tree; painted "350 No. 35"	349.07
Cameron, 0.7 mile east of, 1.2 mile northeast of Gulf, Colorado & Santa Fe Ry. track, at wire fence line between fields, 50 feet southwest of large lone cottonwood tree, 2,000 feet east of sloping ground at edge of bottom land, tree blazed and painted; iron post stamped "Prim. Trav. Sta. No. 10 310"	309.458
Cameron, 0.3 mile east of, about 3,000 feet north of Gulf, Colorado & Santa Fe Ry. track, at fence line, on north margin of east-west road (farm), private telephone line along road, copper nail in root of large cottonwood tree; painted "311 No. 36"	310.50
Cameron, 0.4 mile southwest of, about 800 feet east of Gulf, Colorado & Santa Fe Ry. track, about 6 feet above bottom lands, near wire fence line and row of scattering trees, copper nail in root of hackberry tree; painted "319 No. 37"	318.93
Cameron, 1 mile south of, on road leading across Little River, 80 feet north of cemetery, copper nail in root of oak tree; painted "336 No. 38"	336.01
Cameron, about 1.2 miles southwest of, in center of Cameron-Rockdale road, 250 feet south of highland, 120 feet south of small road culvert; iron post stamped "Prim. Trav. Sta. No. 11 313"	312.764
Cameron pumping station, 175 feet north of plant and 100 feet west of road from Cameron to plant, copper nail in root of large cottonwood tree; painted "315 No. 39"	314.78
Cameron, 1.2 miles south by 1.2 miles west of, at fence line between two open cultivated fields, about 500 feet north of timbered land, in root of lone elm tree; copper nail painted "318 No. 40"	317.03
Cameron, 1.5 miles southwest of, in open field, 100 feet east of wire fence, copper nail in root of lone hackberry tree; painted "319 No. 41"	318.50
Cameron, 2 miles southwest of, 0.2 mile east of San Antonio & Aransas Pass Ry., on edge of gully, copper nail in root of elm tree; painted "314 No. 41"	313.267
Cameron, 2.5 miles southwest of San Antonio & Aransas Pass Ry., Bridge 232.9 over Little River, 35 feet east of north end of trestle, 245 feet north of north end of iron bridge, 250 feet north of river, at milepost "Houston 233;" iron post stamped "Prim. Trav. Sta. No. 12 324"	323.182

	Feet.
Cameron, 3.1 miles southwest of, in timbered pasture about 50 feet east of private pasture road and 300 feet west of Little River, copper nail about 25 feet above bottom lands in root of large post oak tree; painted "341 No. 42"	340.22
Cameron, 3.6 miles southwest of, on west bank of watercourse, ten feet east of wire fence, copper nail in root of ash tree in open field; painted "315 No. 43"	314.63

TAYLOR QUADRANGLE.

Point 3.6 miles southwest of Cameron northwest along highway up Little River to Litttle River station.

Cameron, 4.2 miles southwest of, in timbered pasture covered with mesquite bushes, in root of leaning mesquite tree; copper nail; painted "323 No. 44"	322.88
Cameron, 4.8 miles southwest of, at cross of two fences and joining point of two timbered pastures and two open cultivated fields, copper nail in root of tree at fence line; painted "326 No. 45"	325.42
Cameron, 5.4 miles southwest of, between timbered pasture and large open cultivated field, 8 feet north of wire fence, copper nail in root of elm tree; painted "323 No. 46"	322.51
Tompkins convict farm, at end of long strip of timber about 0.8 mile east of convict quarters, 3 feet west of wire fence between pasture and open field, large cleared field to west and south; iron post stamped "Prim. Trav. Sta. No. 13 328"	327.585
Tompkins convict farm, about 1,000 feet southwest of convict quarters, 75 feet south of wire fence, in large open cultivated field, copper nail in root of large lone oak tree; painted "330 No. 47"	329.214
Tompkins convict farm, 0.4 mile west of quarters, in water course in small pasture, about 300 feet west of house on hill and 20 feet west of wire fence, copper nail in root of ash tree; painted "325 No. 48"	324.15
Tompkins convict farm, 1.1 miles west of quarters, at fence line between two large cleared cultivated fields, copper nail in root of small elm tree; painted "334 No. 49"	333.18
Tompkins convict farm, 1.8 miles west of quarters, west margin of Cameron-Thorndale road, beside wire fence, 85 feet north of small wooden road bridge, 80 feet north of lone double elm tree on east side of road; iron post stamped "Prim. Trav. Sta. No. 14 336"	335.079
Tompkins convict farm, 2 miles west of quarters, in an open cultivated field about 500 feet north of timbered land, copper nail in root of lone double elm tree about 800 feet west of public road; painted "338 No. 50"	337.17
Tompkins convict farm, 2.5 miles west of quarters, on east margin of private field road, in open cultivated field, copper nail in root of large lone forked elm tree; painted "338 No. 51"	337.57
Tompkins convict farm, 3.1 miles west of quarters, in timbered pasture 30 feet south of wire separating pasture from open field, 125 feet east of negro house, copper nail in root of hackberry tree; painted "353 No. 52"	352.54
Tompkins convict farm, 3.9 miles west of quarters, on sloping ground about halfway to summit, at east fence line of timbered pasture about 50 feet wide, open fields east and west, approximately 0.2 mile north of river bottom and 45 feet above bottom lands; iron post stamped "383 Prim. Trav. Sta. No. 15"	382.831

	Feet.
Tompkins convict farm, 4.5 miles west of quarters, in mesquite pasture on south side of cattle lane, 10 feet from wire fence, copper nail in root of small oak tree; painted "399 No. 53"	398.18
Tompkins convict farm, 5 miles west of quarters, on elevated piece of ground in timbered pasture, copper nail in root of large oak tree; painted "394 No. 54"	393.34
Tompkins convict farm, 5.6 miles west of quarters, between two open fields on a sloping hillside about 70 feet from large spreading live oak tree, copper nail in root of elm tree; painted "374 No. 55"	373.67
Tompkins convict farm, 5.9 miles west of quarters, in timbered pasture, copper nail in root of oak tree, 20-foot rise just west; painted "352 No. 56"	351.15
Tompkins convict farm, 6.8 miles west of quarters, in timbered pasture on north bank of dry watercourse (Haw Creek), copper nail in root of large oak stump about 300 feet from Little River; painted "346 No. 57"	346.01
Haw Creek, 400 feet north of, 600 feet northwest of river, at fence line between pasture and open cultivated fields, 80 feet south of junction of fence lines, 10 feet south of large hackberry tree, blazed and marked; iron post stamped "Prim. Trav. Sta. No. 16 350"	349.248
Haw Creek, 0.5 mile northwest of, about 0.3 mile east of Rockdale-Cameron public road, in open cultivated field, 5 feet south of private field road, copper nail in root of large lone elm tree; painted "349 No. 58"	348.95
Haw Creek, 0.8 mile northwest of, on west side of Rockdale-Cameron public road, about 0.5 to 0.8 mile from Little River, at fence line, copper nail in root of large lone pecan tree; painted "355 No. 59"	354.75
Haw Creek, 1.8 miles northwest of, between Cameron-Rockdale and Cummings Bridge roads, in timbered pasture about 100 feet south of dry watercourse, copper nail in root of large oak tree; painted "362 No. 61"	361.62
Haw Creek, 2.4 miles northwest of, between Rockdale-Cameron and Cummings Bridge public roads, on north bank of watercourse, 8 feet south of wire fence, copper nail in root of elm tree; painted "362 No. 62"	361.67
Haw Creek, 2.8 miles northwest of, about 0.2 mile east of Cummings Bridge road, 200 feet south of a series of low hills, on east bank of slough, in open cultivated field, 8 feet east of wire fence; iron post stamped "Prim. Trav. Sta. No. 17 362"	361.135
Haw Creek, 3.3 miles northwest of, about 800 feet north of Cummings Bridge road, in center of large open cultivated field, copper nail in root of lone elm tree; painted "365 No. 63"	364.30
Haw Creek, 3.7 miles northwest of, about 3,000 feet from Cummings Bridge road, in timbered pasture on west bank of slough and 75 feet east of wire fence, in open cultivated field, copper nail in root of a leaning elm tree; painted "360 No. 64"	359.666
Haw Creek, 4.1 miles northwest of, at fence line between pasture and open field, copper nail in root of hackberry tree; painted "366 No. 65"	365.933
Haw Creek, 4.8 miles northwest of, in narrow neck of woods extending out into an open cultivated field, copper nail in root of elm tree; painted "369 No. 66"	368.662

	Feet.
Haw Creek, 5.2 miles northwest of, on land of J. M. Coreley, about 0.5 mile northwest of Coreley's house, at end of narrow neck of woods, large cultivated field to north, 250 feet east of slough; iron post stamped "Prim. Trav. Sta. No. 18 372"	372.088
Buckholtz, about 6 miles south of station, in large open cultivated field, about 1,000 feet west of fringe of low hills, 0.2 mile southwest of house on hill, 40 feet northeast of tree blazed and marked, copper nail in stump of a small double willow tree; painted "378 No. 67"	377.650
Bryant Bridge, 0.9 mile southeast of, in timbered pasture, about 500 feet south of low fringe of hills on north bank of slough, 10 feet south of a wire fence, copper nail in root of willow tree; painted "379 No. 68"	378.252
Bryant Bridge, 600 feet north of, 85 feet west of road to station, at east fence line, at edge of wooded land, 0.1 mile northeast of river; iron post stamped "Prim. Trav. Sta. No. 19 431"	430.817
Bryant Bridge, about 2,500 feet west of crossroad to, on property of Mr. Guschback, about 300 feet east of house, in timbered pasture, 15 feet east of wire fence between pastures, copper nail in root of elm tree; painted "425 No. 69"	424.79
Bryant Bridge, 1.2 miles northwest of, at fence line between pasture and open cultivated field, about 50 feet east of joining of pasture with another field, copper nail in root of large elm tree; painted "389 No. 70"	388.14
Bryant Bridge, 1.8 miles northwest of, in open cultivated field in cluster of four large oak trees, copper nail in root of large leaning oak tree; painted "390 No. 71"	389.31
Bryant Bridge, 2.6 miles northwest of, at fence line between two timbered pastures, 20 feet north of private pasture road, 25 feet east of cleared fields of Frank A. Cox, near tree blazed and marked; iron post stamped "392 Prim. Trav. Sta. No. 20"	391.861
Bryant Bridge, 3.2 miles northwest of, on property of Mr. Clarey, next to land of Mrs. Nichols, 12 feet south of narrow lane, 90 feet southeast of well, 500 feet east of house on hill; lane runs between open cultivated field and pasture and is used mostly as a cattle lane to river; copper nail in root of large elm tree; painted "397 No. 72"	396.14
Bryant Bridge, 3.9 miles northwest of, on left bank of Little River, on west margin of Rogers-Davala public road, 5 to 6 miles from Rogers, 0.1 mile north of road bridge across river, very deep, dry watercourse about 200 feet to north, woods to west, open field to east, copper nail in root of leaning ash tree; painted "402 No. 73"	401.181
Bryant Bridge, 4.5 miles northwest of, 150 feet north of Little River, at foot of hill, 200 feet southeast of open cultivated fields, in timbered bottom land, copper nail in root of leaning ash tree; painted "401 No. 74"	400.95
Bryant Bridge, 4.8 miles northwest of, between two open cultivated fields, on east bank of dry watercourse, copper nail in root of large elm tree; painted "402 No. 75"	401.26
Bryant Bridge, 6 miles northwest of, at wire fence line between timbered pasture and open cultivated field, in southwest corner of field, about 600 feet east of river, 6 feet northeast of tree marked and blazed; iron post stamped "Prim. Trav. Sta. No. 21 405"	404.615

	Feet.
Bryant Bridge, 6.4 miles northwest of, in heavily timbered pasture, about 175 feet west of corner of open field, copper nail in root of large leaning elm tree; painted "405 No. 76"	404.17
Bryant Bridge, 7.5 miles northwest of, in small timbered pasture, 20 feet east of bank of Little River, 200 feet west of rising ground, midway between two wire fences about 200 feet apart, open fields to north, copper nail in root of large oak tree; painted "410 No. 77"	409.450
Bryant Bridge, 8.2 miles northwest of, in timbered pasture 100 feet north of Little River, copper nail in root of large elm tree; painted "413 No. 78"	412.68
Bryant Bridge, 8.7 miles northwest of, at private farm road through bottoms near river running north-south, about 30 feet east of river bank, at a board gate, copper nail in root of hackberry tree; painted "415 No. 79"	414.03
Bryant Bridge, 9.4 miles northwest of, where timbered land runs out in small neck into open fields, open cultivated fields to north and south, 30 feet north of wire fence, copper nail in root of double hackberry tree; painted "413 No. 80"	412.32
Reid bottom, in large open cultivated field, about 800 feet west of house occupied by W. H. Harris, 1,000 feet south of timber, from 0.5 mile to 1 mile east of river, 8 feet northeast of large lone cottonwood tree, 10 feet south of private field road; iron post stamped "Prim. Trav. Sta. No. 22 413"	412.645
Reid bottom, 800 feet west of house occupied by Will Harris, 1,000 feet south of timber, 0.5 mile east of Little River, 1,000 feet west of rising ground, in open cultivated field, 10 feet south of private farm road through fields, copper nail in root of large double cottonwood tree; painted "412 No. 81"	411.482
Burgess, 2 miles south of, in hedge of trees between two open fields, on east margin of field road, 25 feet west of wire fence, old sunken road to east, copper nail in root of hackberry tree; painted "419 No. 82"	418.11
Burgess, 1.5 miles south of, in open field in bottom of dry watercourse, 50 feet north of private farm road through field, copper nail in root of hackberry tree; painted "419 No. 83"	418.91
Burgess, 0.8 mile south of, in large open cultivated field, copper nail in root of pecan tree; painted "426 No. 84"	425.26
Burgess (Reids Lake), 425 feet east of wire river bridge, 450 feet northeast of post office, 200 feet north of Reids Lake, 36 feet east of dry watercourse, 8 feet east of blazed and marked tree; iron post stamped "Prim. Trav. Sta. No. 23 430"	429.149
NOTE.—The line here crosses Little River to the southwest side.	
Burgess, wagon bridge over Little River, elevation of center; water surface 40 feet lower	434.94
Burgess, 3,200 feet west of, on brushy tree line between two large open cultivated fields on east margin of private field road running north-south, copper nail in root of hackberry tree; painted "432 No. 85"	430.74
Burgess, 1.2 miles west of, in wooded pasture, 50 feet east of wire fence, copper nail in root of hackberry tree; painted "434 No. 86"	432.44
Burgess, 2 miles west of, on property of Hugh Cole, 400 feet west of house, 15 feet north of wire fence, sloping hillside, in narrow strip of timber, copper nail in root of oak tree; painted "467 No. 87"	465.58

	Feet.
Little River, 2.4 miles south of station, Missouri, Kansas & Texas Ry. bridge over Little River, in southeast pier of bridge 889.8; aluminum tablet stamped "449 No. 24 Prim. Trav. Sta."	447.206
Little River, 0.4 mile south of station, on Missouri, Kansas & Texas Ry. tracks, at telephone post, 1 post south of milepost No. 888, spike in post about 1 foot above surface of ground; painted "489 No. 89"	487.98
Little River, Missouri, Kansas & Texas Ry. station, 6.8 miles south of Temple, in front of station; top of rail	502.1
Little River, 855 feet north of station, on Missouri, Kansas & Texas Ry., east side of track, 4 feet west of wire fence, within right of way, 42 feet north of telegraph pole, 108 feet south of wooded pasture; iron post stamped "504 No. 25"	503.562

MARLIN QUADRANGLE.

Milepost 114 north along International & Great Northern R. R. and highway on east side of Brazos River to point 10.4 miles southeast of Waco.

Milepost 115, 40 feet west of track, 10 feet west of pole; iron post stamped "291 63 Prim. Trav. Sta. 105 A"	294.772
Milepost 116, 330 feet south of, north bent on west side of railroad trestle 204; top of spike painted "294 107"	297.380
Railroad bridge 206, north end, west side; top of abutment, stone painted "295 108"	298.878
Milepost 117, 3 feet east of, 25 feet west of track; iron post stamped "Prim. Trav. Sta. 106 A 299 64"	302.676
Milepost 118; spike painted "303 110"	306.50
Milepost 119, 10 feet west by 4 feet south of, 40 feet west of track; iron post stamped "Prim. Trav. Sta. 107 A 294 65"	297.249
Milepost 120; spike painted "305 113"	308.28
Bufkin, 1 mile north of, 4 feet north of milepost 121, 40 feet west of track; iron post stamped "Prim. Trav. Sta. 108 A 301 66"	304.889
Milepost 122; spike painted "302 116"	305.15
Bufkin, 3 miles north of, 13 feet southwest of Falls-Robertson county-line post, 4 feet north of milepost 123; iron post stamped "Prim. Trav. Sta. 109 A 303 67"	306.971
Milepost 124; spike painted "304 119"	307.71
Milepost 125, 4 feet north of, 30 feet west of track; iron post stamped "Prim. Trav. Sta. 110 A 309 68"	312.142
Milepost 126, in base of; spike painted "310 122"	313.60
Milepost 127, 3 feet east of, 25 feet north of track; iron post stamped "Prim. Trav. Sta. 111 A 315 69"	318.696
Highbank, in front of station; top of rail	323.65
Trestle 224, north end, east side, 450 feet north of station, in top of bent; spike painted "319 126"	322.379
Highbank, 1 mile north of, 4 feet north of milepost 129, 30 feet north of track; iron post stamped "Prim. Trav. Sta. 112 A 319 70"	322.838
Highbank, 3 miles north of, 4 feet north of milepost 131, 30 feet west of track; iron post stamped "Prim. Trav. Sta. 113 A 320 71"	323.575
Highbank, 5 miles north of, 4 feet north of milepost 133, 30 feet west of track; iron post stamped "331 72 Prim. Trav. Sta. 114 A"	334.947
Highbank, 6 miles north of, in milepost 134; spike painted "327 134"	330.31

	Feet.
Highbank, 7 miles north of, 4 feet south of milepost 135; 30 feet west of track; iron post stamped "327 73 Prim. Trav. Sta. No. 115 A"	330.711
Highbank, 9 miles north of, 4 feet north of milepost 137, 30 feet north of track; iron post stamped "364 74 Prim. Trav. Sta. 116 A"	367.762
Highbank, 10 miles north of, in milepost 138; spike painted "373 140"	376.69
Marlin, Falls County courthouse, east entrance; aluminum tablet stamped "Prim. Trav. Sta. 117 A 394 75"	398.078
Marlin, 0.5 mile west of, 200 feet east of road bridge, 25 feet south of road, spike in root of elm tree; painted "342 142"	345.877
Marlin, 1 mile west of, spike in root of mesquite tree on south side of road; painted "337 143"	340.41
Marlin, 1.5 miles west of, spike in root of hackberry tree, north side of road; painted "339 144"	343.00
Marlin, 2 miles west of, 200 feet north of Elm Grove Church, 15 feet north of pecan tree, south side of road; iron post stamped "339 76 Prim. Trav. Sta. 118A"	342.510
Marlin, 2.5 miles west of, northwest corner of road to north, spike in root of hackberry tree; painted "339 145"	342.55
Marlin, 4 miles west of, at southeast corner of John Tuyman's farm, at gate, iron post stamped "Prim. Trav. Sta. 119A 341 77"	344.472
Marlin, 3.5 miles north by 2 miles west of, at John Slaughter's house, south side of road, 12 feet north of house, 4 feet north of telegraph pole; iron post stamped "Prim. Trav. Sta. 120A 346 78"	350.230
Marlin, 3 miles west of, on Rockdam road, spike in root of post oak tree; painted "366 154"	369.40
Marlin, 3.5 miles west of, on Rockdam road, opposite African Methodist Episcopal Church, at road to north; iron post stamped "Prim. Trav. Sta. 121A 358 79"	361.329
Marlin, 4 miles west of, spike in root of elm tree on north side of road; painted "365 155"	368.73
Marlin, 4.5 miles west of, on Rockdam road, spike in root of hackberry tree; painted "345 156"	348.76
Rockdam Bridge, 720 feet east of, west edge of gully, spike in root of hackberry tree; painted "347 157"	350.89
Rockdam Bridge over Brazos River, 1,670 feet north of, east side of river, east margin of road; iron post stamped "353 80 Prim. Trav. Sta. 122A"	356.745
Rockdam Bridge, 2.7 miles north of, 50 feet west of deserted house, 4 feet north of telegraph pole; iron post stamped "357 81 Prim. Trav. Sta. 123A"	360.36
Rising Sun Methodist Episcopal Church (negro), in front of, at margin of road; iron post stamped "Prim. Trav. Sta. 124A 388 82"	391.938
Opposite ginhouse, west margin of road, in root of elm tree; spike painted "376 164"	380.13
Waco, 12.8 miles southeast of, on west side of road, 0.2 mile north of road to Riesel, at fence line; iron post stamped "414 83 Prim. Trav. Sta. 125A"	417.754
Waco, 10.4 miles southeast of, on west margin of road, at fence line, under oak tree; iron post stamped "427 84 Prim. Trav. Sta. 126A"	430.916

Black Bridge north along west side of river to Ellison's place, thence across river to milepost 124.

	Feet.
Calvert, about 3 miles northwest of milepost 113, International & Great Northern R. R., 30 feet west of track, 2 feet south of milepost; iron post stamped "Prim. Trav. Sta. 104A 295"	298.179
Calvert, 0.5 mile west of, at Black Bridge, top of north side of west pier; aluminum tablet stamped "Prim. Trav. Sta. No. 31 300"	299.481
Black Bridge, 3,000 feet north of, between 300 and 500 feet west of river bank, in timbered pasture, in root of oak tree; copper nail stamped "U.S.B.M. 309"	309.24
Black Bridge, 1 mile north of, 75 feet west of bank of river, at edge of open field, and timber; nail in root of small elm	296.92
Black Bridge, 2.5 miles north of, in open field, near fence, about 600 feet west of river; iron post stamped "Prim. Trav. Sta. 32 299"	298.872
Pond Creek, 500 feet north of, in open field, nail in pecan tree; marked "301.7"	301.61
Black Bridge, 5.2 miles north of, west edge of river bottom, foot of small hill, near fence; iron post stamped "Prim. Trav. Sta. No. 33 305"	304.453
Black Bridge, 6.9 miles north of, at fence line separating two fields of Molly Bailey, about 500 feet from river, 400 feet south of bayou, in old cornfield; iron post stamped "Prim. Trav. Sta. 34 320"	320.317
Black Bridge, 6.9 miles north of, Molly Bailey's place, just south of large bayou about 1,000 feet from river, copper nail in root of 12-inch pecan tree; marked "315"	314.83
Forks of bayou, about 300 feet from river, 400 feet southeast of deserted cabin, copper nail in 18-inch chinaberry tree; marked "320"	319.78
Richard Ellison's place (in cotton field), 3 miles south of road that leads to river from house, copper nail in two-pronged chinaberry tree, about 1 foot above ground; marked "309.9"	309.70
Highbank Bridge, 4 miles south of, on Richard Ellison's place, about 5 miles east of house, 600 feet north of road leading to river from house, on point of high land, at gate in fence; iron post stamped "Prim. Trav. Sta. No. 35 326"	326.183

Ellison's place north along west side of river to Highbank Bridge and across bridge to station.

Highbank Bridge, 2 miles south of, 75 feet east of fence corner, south of lane that leads from high lands to river; iron post stamped "Prim. Trav. Sta. No. 36 324"	323.413
Highbank Bridge, 1 mile south of, at north edge of timber, in fence line, copper nail in 12-inch tree; marked "319.4"	318.36
Highbank Bridge, 925 feet southwest of, on northwest side of road, 2 feet from wire fence; iron post stamped "Prim Trav. Sta. No. 37 316"	315.507
Highbank, 1.4 miles west of, 0.5 mile east of bridge, in small grove of trees, on south side of Highbank-Rosebud road, copper nail in root of elm; marked with keel "316.2"	316.06
Highbank, 0.5 mile west of, 150 feet east of barn, in pasture on north side of Highbank-Rosebud road, 20 feet from wire fence, copper nail in root of large pecan tree; marked "320.9"	320.71

Point near Highbank Bridge along west side of river north to Marlin Bridge, thence east to point near Marlin.

	Feet.
Highbank, 2.2 miles west of, on north margin of Highbank-Rosebud road, 915 feet west of end of bridge over river; iron post stamped "Prim. Trav. Sta. No. 37 315"	315.507
Highbank Bridge, 0.6 mile northwest of, 100 feet west of river bluff, between two cultivated fields, in lane, wire nail in root of elm tree	318.31
Highbank Bridge, 1 mile northwest of, 200 feet west of river bank, in cleared field, wire nail in root of large ash tree	318.47
Highbank Bridge, 1.7 miles northwest of, 100 feet from river, 600 feet east of rising ground, at edge of timber with cleared fields to south and west, wire nail in root of small leaning ash tree	318.647
Highbank Bridge, 2 miles north of, in field between river and high land, nail in root of pecan tree	325.613
Highbank Bridge, 2.7 miles north of, at south edge of lane, in thicket; iron post stamped "Prim. Trav. Sta. No. 38 328"	327.380
Cedar Springs Bridge, 1.1 miles south of, at south end of lumber road, nail in root of 12-inch hackberry tree which stands on edge of 5-foot bank; marked "321.9"	321.73
Cedar Springs Bridge, 0.5 mile south of, northeast side of wood road, 1,200 feet southeast of Y road, nail in root of 12-inch elm; marked "319.9"	319.72
Cedar Springs Bridge, 1,200 feet west of, on north side of Marlin road at fence line; iron post stamped "Prim. Trav. Sta. No. 39 326"	325.299
Cedar Springs Bridge, 1.2 miles northwest of, on south edge of clearing about 300 feet north of Pond Creek, nail in root of 10-inch oak; marked "323.8"	323.65
Cedar Springs Bridge, 1.6 miles north of, north edge of clearing near fence line, nail in root of 20-inch elm tree; marked "327.8"	327.65
Cedar Springs Bridge, 2.4 miles north of, 500 feet south of Jones's ranch, in thicket, about 600 feet from river; iron post stamped "Prim. Trav. Sta. 40, 329"	328.395
Jones's ranch, 0.6 mile north of, just south of small cluster of trees; nail in 20-inch oak at edge of river, marked "330.6"	330.42
Ford over Brazos River at Marlin clubhouse, 0.3 mile south of, nail in root of 15-inch elm which stands between two clusters of trees, about 1,200 feet from river; marked "332.2"	332.05
Ford at Marlin clubhouse, 0.2 mile northwest of, east side of road, 300 feet southwest of angle, 387 feet southwest of river; iron post stamped "Prim. Trav. Sta. No. 41, 335"	335.132
Ford at Marlin clubhouse, 0.6 mile north of, at edge of thicket, on fence line, nail in root of 15-inch oak; marked "337.9"	337.73
Ford at Marlin clubhouse, 1.2 miles north of, nail in root of 18-inch pecan tree which stands alone at edge of highland; marked "342.8"	342.62
Ford at Marlin clubhouse, 1.6 miles north of, nail in root of 24-inch pecan tree which stands alone in field about 300 feet west of timber; marked "340.4"	340.22
Ford at Marlin clubhouse, 2.2 miles north of, nail in root of elm tree at north edge of clearing, 300 feet from deserted cabin; marked "340.9"	340.68

	Feet.
Marlin Bridge, 1.6 miles south of, north side of wood road, nail in root of leaning ash tree; marked "339.1"	338.85
Marlin Bridge, 1.2 miles south of, north edge of timber, in fence corner; iron post stamped "Prim. Trav. Sta. No. 42, 340"	340.447
Marlin Bridge, 0.6 mile south of, north bank of creek, nail in root of 30-inch pecan tree; marked "344.4"	344.14
Marlin Bridge, 500 feet southwest of, 300 feet southwest of negro cabin; nail in tree marked "344.1"	343.87
Marlin, 2.5 miles west of, at northwest corner of three corners, copper nail in root of hackberry tree; marked "342.8"	342.55

Marlin Bridge north along west side of river to Rockdam Bridge.

Marlin Bridge, 0.4 mile north of, 300 feet north of negro cabin, 125 feet southwest of river, near fence line, between open field and timbered pasture; iron post stamped "Prim. Trav. Sta. No. 43, 358"	357.483
Marlin Bridge, 1.1 miles north of, on highland in clearing, 600 feet south of deserted cabin, nail in root of dead pecan tree; marked "381"	380.50
Cow Bayou, on south bank of, 900 feet east of wooden bridge over bayou; iron post stamped "Prim. Trav. Sta. No. 44, 347"	346.549
Cow Bayou, 0.4 mile north of, copper nail in root of 18-inch elm in field; marked "34.8"	346.12
Sawyer plantation, 0.4 mile southwest of house, at south edge of ditch, 400 feet east of road, copper nail in root of 6-inch two-forked elm; marked "346"	345.84
Sawyer plantation, 0.7 mile northeast of house, 100 feet south of fence corner, on fence line, copper nail in root of 30-inch oak	349.96
Samples (J. M.) farm, southwest of Rockdam Bridge, at south edge of old lane, about 0.3 mile northeast of negro cabin, on highland; iron post stamped "Prim. Trav. Sta. No. 45, 348.6"	347.707
Rockdam Bridge, 2 miles west of, 300 feet north of public road, copper nail in root of 18-inch elm; marked "347.136"	356.25
Rockdam, 2.7 miles west of, at north edge of lane, 300 feet east of cabin, to south of lane, copper nail in root of 30-inch elm; marked "360"	360.01
Rockdam Bridge, 1.8 miles west of, on west side of road, where it angles east; iron post stamped "Prim. Trav. Sta. No. 46, 361"	361.045

TEMPLE QUADRANGLE.

Point near Rockdam Bridge north along west side of river to point 5 miles south of Waco.

Rockdam Bridge, 3.2 miles west of, 0.5 mile north of lane in field about 800 feet east of timber line, copper nail in root of lone pecan; marked "356"	355.73
Gurley's plantation, in field about 500 feet southeast of negro cabin, with red brick chimney, copper nail in root of 30-inch pecan tree	357.21
Gurley, 3,000 feet northeast of station, on Gurley's plantation, about 0.2 mile southeast of house, at lone cedar tree; iron post stamped "Prim. Trav. Sta. No. 47 358"	357.690

	Feet.
Gurley's plantation, 0.5 mile north of, copper nail in root of 15-inch elm; marked "359"	358.86
Gurley, on San Antonio & Aransas Pass Ry., 1 mile north of, at junction of levee around Gurley plantation and railway, at south end of bridge "275.6," spike in telegraph pole; marked "367"	367.01
Gurley, 1 mile northeast of station, 70 feet north of milepost 268 on San Antonio & Aransas Pass Ry., 3 feet from right of way fence; iron post stamped "Prim. Trav. Sta. No. 48, 369"	368.289
Milepost 277 in base of, on San Antonio & Aransas Pass Ry.; spike, marked "380"	380.05
Milepost 278, 29 feet north of, 5 feet from east right of way fence; iron post stamped "Prim. Trav. Sta. No. 49 394"	394.332
Milepost 279; spike in post, marked "382"	381.13
Downs, 0.5 mile south of, 150 feet south of road crossing, 3 feet from right of way, at milepost 280; iron post stamped "Prim. Trav. Sta. 50 402"	400.434
Downs, 0.4 mile east of, nail in root of 12-inch tree at edge of bottom; marked "380"	378.52
Downs, 1 mile northeast of, in 15-inch pecan tree in scattered timber, 300 feet south of road, 900 feet southeast of negro cabin, nail; marked "376"	375.24
Downs, 1.5 miles northeast of, on south side of old lane, about 400 feet east of negro cabin; iron post stamped "Prim. Trav. Sta. No. 51 380"	378.299
Downs, 2.2 miles northeast of, at fence line to north of road, copper nail in 15-inch hackberry; marked "379"	378.08
Downs, 2.9 miles northeast of, on north bank of Flat Creek, copper nail in small elm tree; marked "381"	380.48

Gurley north up west side of river to Downs.

Gurley's plantation, 0.5 mile north of, nail in root of 15-inch elm tree	358.91
Gurley, about 1.2 miles north of, in large open field on west margin of a low depression, nail in root of lone pecan tree; marked "368 P. T. 97"	367.34
Gurley, about 2.2 miles north of, at southeast corner of junction of Y road; iron post stamped "Prim. Trav. Sta. No. 56 367"	366.552
Gurley, about 3 miles north of, on property of Clif Torrence, in root of elm tree; copper nail marked "P. T. 99 elev. 366"	365.19
Gurley, about 3.5 miles north of, in open cultivated field, on property of Dr. Steiner, copper nail in root of lone pecan tree; marked "P. T. 101 elev. 374"	373.43
Gurley, about 4 miles north of, at wire fence near Bull Creek, about 400 feet northeast of tenant house and about 1,000 feet north of public road; iron post stamped "Prim. Trav. Sta. No. 57 379"	379.058
Downs, 1.3 miles southeast of, in open field, about 40 feet south of a ditch with brushy fringe in root side, copper nail in root of large lone pecan tree	375.27
Downs, 0.8 mile southeast of, in open field, copper nail in root of large lone pecan tree; marked "P. T. 103 Elev. 376"	375.27
Downs store, about 0.5 mile east of, at edge of bottom land, copper nail in root of cottonwood tree; marked "P. T. 86 Elev. 380"	378.57

Point 3.6 miles southwest of Cameron northwest along highway up Little River to Little River station.

	Feet.
Temple, at crossing of Missouri, Kansas & Texas Ry. and Gulf, Colorado & Santa Fe Ry., 60 feet west of Missouri, Kansas & Texas Ry. tracks and 40 feet north of Gulf, Colorado & Santa Fe Ry. track, halfway between telephone pole and its guy-wire pole, in limestone post; bottom of square hole (Coast and Geodetic Survey bench mark)	673.464

WACO QUADRANGLE.

Point 10.4 miles southeast of Waco along east side of Brazos River to Waco.

Waco, 8.3 miles southeast of, 1 mile south of Houston & Texas Central R. R., on road to Riesel, 200 feet north of gate; iron post stamped "Prim. Trav. Sta. 127A 421 85"	425.203
Waco, about 7.5 miles south of south bank of Shaw Creek, at fork in road, in root of Spanish oak; spike painted "387 179"	391.36
Waco, 6 miles southeast of, at southeast fence corner, 100 feet west of Houston & Texas Central R. R. trestle, 130 feet north of steel wagon bridge; iron post stamped "374 86 Prim. Trav. Sta. 128A"	378.322
Waco, 4.7 miles southeast of, at fence line, 75 feet west of section house on Houston & Texas Central R. R., east margin of road; iron post stamped "385 87 Prim. Trav. Sta. 129A"	388.620
Waco, 2.5 miles southeast of, 175 feet east of J. McGanghy's house, at gate, west margin of road; iron post stamped "393 88 Prim. Trav. Sta. 130A"	396.561
Waco, Missouri, Kansas & Texas Ry. bridge over Brazos River, east end, north side, in top of abutment; aluminum tablet stamped "Prim. Trav. Sta. No. 131A 397 89"	396.489
Waco, southeast corner of South First and Jackson streets, top of hydrant (Coast and Geodetic Survey bench mark)	403.001
Waco, brick building on the southeast corner of South Third and Jackson streets, occupied by McCleary's feed store, 1.5 feet from southernmost window toward Missouri, Kansas & Texas Ry. (Coast and Geodetic Survey bench mark)	413.183
Waco, northwest corner of South Fifth and Jackson Streets, in brick building occupied by bottling works, 10 inches below third window from front of building on side toward Missouri, Kansas & Texas Ry. (Coast and Geodetic Survey bench mark)	414.479

Point 5 miles south of Waco along west side of river to Waco.

Waco, 5 miles southeast of, 600 feet southwest of red house, north side of lane, 18 inches from wire fence, in open field; iron post stamped "Prim. Trav. Sta. No. 52 386"	384.954
Waco, 4.4 miles southeast of, 0.5 mile northeast of red house, 50 feet west of fence corner at north side of old lane, 600 feet south of lane through bottom, nail in root of 15-inch elm tree; marked "382"	381.28
Waco, 4 miles southeast of, 400 feet northeast of edge of bottom land, 600 feet east of large barn, at north edge of field, about 0.2 mile east of main Waco road, near wire fence; iron post stamped "Prim. Trav. Sta. No. 53 387"	385.957

	Feet.
Waco, 3.5 miles southeast of, 75 feet north of creek, nail in root of small elm in field	390.95
Waco, 2.8 miles southeast of, 47 feet northeast of center of San Antonio & Aransas Pass Ry., at north corner of main Waco road crossing, in corner of right-of-way fence; iron post stamped "Prim. Trav. Sta. No. 54 403"	403.314
Waco, in north end east retaining wall for Missouri, Kansas & Texas Ry. bridge; aluminum tablet	396.489

Austin, Bandera, Bastrop, Blanco, Boerne, Burnet, Flatonia, Fredericksburg, Georgetown, Giddings, Halstead, Llano, New Braunfels, Sabinal, San Antonio Special, San Marcos, and Uvalde Quadrangles and region adjacent to San Antonio Special Quadrangle.

ATASCOSA, BANDERA, BASTROP, BEXAR, BLANCO, BURNET, CALDWELL, COMAL, FAYETTE, FRIO, GONZALES, GUADALUPE, HAYS, KENDALL, KERR, LAVACA, LEE, LLANO, MASON, MEDINA, SAN SABA, TRAVIS, UVALDE, WILLIAMSON, WILSON, AND ZAVALLA COUNTIES.

The elevations herein given are based on the corrected elevation of the city hall bench mark at San Antonio, now accepted as 653.212 feet above mean sea level, as determined from Coast and Geodetic Survey precise leveling.

The leveling in the various quadrangles was done by J. A. Hinman, Thomas Winsor, and M. S. Bright, between 1896 and 1901. Additional leveling in the San Marcos quadrangle was done by F. A. Nussle in 1906. The leveling by Hinman was done in the Austin, Bandera, Bastrop, Boerne, Flatonia, Halstead, New Braunfels, Sabinal, San Antonio special, San Marcos, and Uvalde quadrangles in 1896 and 1897; that by Winsor in the Austin, Bastrop, Blanco, Fredericksburg, Georgetown, Giddings, and Llano quadrangles in 1897 and 1898; and that by Bright in the Boerne, Fredericksburg, and San Antonio special quadrangles in 1900 and 1901.

AUSTIN QUADRANGLE.

Kyle to McNeill along International & Great Northern R. R.

	Feet.
Buda, 1,000 feet north of station, 7 feet south of telegraph pole, 35 feet east of track, 60 feet south of crossing of old San Antonio and Austin road; iron post stamped "711"	705.619
Bear Creek, International & Great Northern R. R. bridge, 1 mile southwest of Manchaca, in east end of north rock pier; copper bolt stamped "U.S.G.S. 651 B. M."	645.175
Manchaca, in front of station, center of track	696.900
Williamson Creek railroad bridge, 6 miles north of Manchaca and 5 miles south of Austin, top of east end of south rock pier; copper bolt stamped "U.S.G.S. 641 B. M."	633.180
Austin, highway bridge over Colorado River, in west end of south rock pier; copper bolt stamped "U. S. G. S. 476 B. M."	469.957
Austin, second telegraph pole west of the Houston & Texas Central R. R. freight depot, 5 feet west of; iron post stamped "471"	465.541
Austin, in southwest corner of postoffice, facing Colorado Street; bronze tablet stamped "508"	502.111

	Feet.
Austin, 5 miles north of, south side of Bull Creek road, 750 feet north of signboard at Hooper switch, 27 feet east of track; iron post stamped "702 SA"	694.029
Duval, 2.75 miles south of, south side of Fiskville public road, 250 feet south of Amboy station, 22 feet west of track; iron post stamped "758 SA"	749.977
Amboy, in front of station; top of rail	750.700
Duval, 100 feet north of switch head block, 42 feet west of track, 6 feet south of telegraph pole, top of flat limestone rock 15 inches in diameter; bronze tablet stamped "797 SA"	789.173
McNeil, 75 feet north of intersection of International & Great Northern R. R. and Houston & Texas Central R. R., 22 feet northeast of the latter's track, top of and near acute point of triangular limestone rock; bronze tablet stamped "836 SA"	828.401

McNeil northwest along Houston & Texas Central R. R., western division.

McNeil, 3.25 miles northwest of, west side of public road, 22 feet south of track, 500 feet east of section house; iron post stamped "857 SA"	849.150

Elysium via Garfield and Creedmore to Manchaca.

Texas Hill triangulation station, 2.3 miles southwest of Elysium post office; rock marked "U. S. G. S."	602.590
Pilot Knob, 1 mile east of, 3.77 miles from Cedar Creek and Austin road, at intersection of Creedmore road with Luling and Austin road, in corner of fence; iron post stamped "534"	529.100
Creedmore, junction of Creedmore-Austin and Creedmore-Manchaca roads, 5.6 miles southwest of the lower Luling and Austin road, in southwest corner of field fence; iron post stamped "637"	631.508
Manchaca, 2 miles southeast of, at intersection of Creedmore-Manchaca and Old San Antonio-Austin roads, north side; iron post stamped "649"	643.493

Austin to Cedar Valley via Oak Hill.

Oak Hill, 0.75 mile west of, intersection of Bee Caves and Cedar Valley roads, in corner of fence; iron post stamped "839"	831.207
Cedar Valley, forks of Dripping Springs and Johnson City roads; iron post stamped "1085"	1,077.610

Cedar Valley to Manchaca.

Cedar Valley, 8.64 miles southeast of, at crossing of Cedar Valley-Manchaca and Mountain City-Oakhill roads; iron post stamped "781"	775.434

BANDERA QUADRANGLE.

Sabinal to Bandera along public roads.

Sabinal, 14.5 miles northeast of, 45 feet west of road, 300 feet north of fords of Main and Litttle Seco rivers; iron post stamped "1168"	1,159.989
Sabinal, 21 miles northeast of, at forks of road to Anton Ney; iron post stamped "1338"	1,329.885

	Feet.
Sabinal, 28 miles northeast of, 500 feet east of Hondo River, 23 miles north of Hondo, crossing of old Bandera road and north and south road, from Hondo to Bandera, at southwest corner of intersection; iron post stamped "1227"	1,218.410

Hondo and Bandera county road.

Sabinal, 35.25 miles northeast of, junction of Hondo and Utopia Roads to Bandera near Commissioners Creek, 150 feet west of milestone 12 from Bandera, and 400 feet north of E. A. Brewer's house, northeast of road junction; iron post stamped "1490"	1,481.451

Bandera and Utopia county road.

Bandera, 100 feet east of Sixth mile post west of, 500 feet east of gate, 25 feet north of road; iron post stamped "1449"	1,440.711
Bandera, county courthouse, in southwest corner of rock wall; bronze tablet stamped "1265"	1,257.000

Bandera to center point along public roads.

Bandera, 5.5 miles north of, forks of Bandera-Kerrville and Bandera-Center Point roads; iron post stamped "1407"	1,398.647
Center Point, 6 miles south of, 12 miles north of Bandera, summit of Elm Pass, 25 feet west of mile post 6, at fence corner; iron post stamped "1744"	1,736.049

BASTROP QUADRANGLE.

Bastrop to Elgin along Missouri, Kansas & Texas Ry.

Bastrop, 100 feet southeast of freight station, 50 feet south of Bastrop and La Grange County road; iron post stamped "372"	366.552
Bastrop, in front of station; top of rail	366.3
Bastrop, courthouse, northwest side of main entrance, in brick wall; bronze tablet stamped "377"	371.587
Bastrop, 1.66 miles north of, top of coping, northeast end of East Rock pier, Piney Creek; copper bolt stamped "365 SA"	357.396
Bastrop, 4.5 miles north of, 3 feet outside of southeast corner of right of way fence at crossing of Bastrop and Elgin public road; iron post stamped "460 SA"	452.548
Sayersville, 1.75 miles south of, 5 feet east of northwest corner of right of way fence at public road crossing, half distance between fourth and fifth telegraph poles south of milepost 945; iron post stamped "449 SA"	440.996
Sayersville, in front of station; center of main track	407.2
Sayersville, 2 miles north of, 650 feet north of head block of Cary Lacier coal mine spur, 35 feet west of center of track at road crossing; iron post stamped "468 SA"	460.050
Elgin, 2.5 miles south of, 15 feet northeast of the southwest corner of right of way fence, 20 feet west of center of track, at Bastrop and Elgin road crossing; iron post stamped "530 SA"	522.089
Elgin, in front of freight station; top of rail	571.4
Elgin, at union passenger station, 7 feet east of southeast corner of small park, 115 feet east of crossing of Missouri, Kansas & Texas Ry. and the Houston & Texas Central R. R., 20 feet north of Houston & Texas Central R. R. main track; iron post stamped "576 SA"	568.010

Elgin to Giddings along Houston & Texas Central R. R.

	Feet.
Elgin, 2.25 miles southeast of, 15 feet east of northwest corner of right of way fence at crossing of the Elgin and McDade public road, and 5 feet northwest of 18 inch post oak tree at intersection of lane; iron post stamped "566 SA"	557.964
Elgin, 5.75 miles southeast of, 100 feet south of railroad at intersection of a settlement road with the Elgin and McDade public road, 650 feet east of section house 13; iron post stamped "517 SA"	509.094
McDade, in front of station; center of track	558.1
McDade, 50 feet north of northeast corner of passenger station; iron post stamped "568 SA"	560.007
McDade, 2 miles southeast of, top of rock masonry wall around southwest end of 24-inch drain pipe culvert, 250 feet southeast of the crossing of the McDade and Paige public road; copper bolt stamped "588 SA"	580.517
McDade, 6 miles southeast of, halfway between mileposts 71 and 72, northeast face of brick retaining wall built around double 24-inch drain pipe culvert; bronze tablet stamped "495 SA"	487.148
Paige, 1.75 miles west of, 150 feet southwest of the McDade and Paige public road crossing and 250 feet northwest of milepost 69, vertical side of brick coping on wing wall south end of 24-inch drain pipe culvert 157; bronze tablet stamped "578 SA"	570.221
Paige, 180 feet northeast of passenger station, 7 feet east of northeast corner of small park; iron post stamped "549 SA"	541.363
Paige, in front of station; center of main track	544.0
Paige, 3 miles southeast of, midway between seventh and eighth telegraph poles northwest of milepost 64, 10 feet from southeast corner of right of way fence at the crossing of the Paige and Giddings public road, 38 feet south of center of track; iron post stamped "528 SA"	520.157
Paige, 7 miles southeast of, 0.5 mile southeast of milepost 61, top of rock coping over south end of 18-inch drain pipe culvert; copper bolt stamped "520 SA"	512.024

Winchester to Bastrop via Alum Creek.

Winchester, 50 feet north of station, 45 feet east of middle of main track; iron post stamped "335 SA"	327.554
Winchester, in front of station; center of main track	329.7
Winchester, 3 miles west of, east side of Pin Oak Creek, fork of road to Hodgins Ford of Colorado River; iron post stamped "300 SA"	292.708
Winchester, 5.5 miles west of, forks of Lagrange-Bastrop public road and public road leading to Smithville via Hodgins Ford of Colorado River; iron post stamped "364 SA"	356.638
Winchester, 8.75 miles west of, 1 mile east of P. D. Creek, 75 feet east of forks of the Lagrange and Bastrop public road and public road leading to Smithville via Eblin Ford of Colorado River; iron post stamped "349 SA"	341.898
Alum Creek, 4.25 miles southeast of, 2 miles north of Smithville, 9 feet east of 24-inch pecan used as fence corner post, 15 feet northwest of intersection of Smithville-Bastrop and Lagrange-Bastrop public roads; iron post stamped "331 SA"	323.791

	Feet.
southeast of, at mouth of Jones Lane leading , south of middle of main road; iron post	335.717
st of brick store, 7.33 miles southeast of th of road, in corner of fence; iron post	348.633
utheast of, 50 feet west of bridge over Copperas uth of Bastrop-Lagrange road; iron post stamped	398.584

Bastrop to Giddings along public road.

miles east of, 35 feet northeast of forks of road, 100 of small prairie; iron post stamped "528 SA"	519.881
miles east of, on Alum Creek-Paige road, 2.225 feet south- of Bastrop-Giddings road; iron post stamped "503"	497.635
p, 12 miles east of, east bank of Gravely Creek, 20 feet south main road and 30 feet east of middle of creek; iron post tamped "466 SA"	457.993
astrop, 15.5 miles east of, 800 feet northeast of the Pin Oak Creek crossing, 12 feet north of road, 15 feet northwest of field fence corner; iron post stamped "414 SA"	406.002
Giddings, 7.5 miles southwest of, 50 feet northeast of intersection of Serbin road, 50 feet northeast of the Bastrop and Lee county line, at northeast fence corner; iron post stamped "476 SA"	467.901
Giddings, 5 miles southwest of, 30 feet south of crossroads, 1,000 feet west of Rabbs Creek; iron post stamped "475 SA"	466.833

Paige to Bastrop along public road.

Paige, 1.75 miles west of, 1.5 feet east of west fence line and 150 feet north of summit of ridge; iron post stamped "611 SA"	602.665
Paige, 4.5 miles southwest of, 30 feet south of mouth of lane, 2 feet west of east fence line; iron post stamped "535 SA"	526.687
Paige, 7.75 miles southwest of, forks of old San Antonio and Giddings public roads; iron post stamped "455 SA"	446.787
Bastrop, 6.5 miles northeast of, at forks of settlement road, 4.5 miles north of Bastrop-Giddings road; iron post stamped "486"	480.470

Lexington to Paige along public roads.

Lexington, 0.5 mile east of station, 45 feet south of crossing of Giddings-Lexington public road; iron post stamped "465 SA"	456.654
Lexington, 1.5 miles southwest of, 35 feet southwest of the intersection of road connecting the Lexington-Fedor and Lexington-McDade public roads; iron post stamped "402 SA"	393.645
Lexington, 4.25 miles southwest of, 70 feet south of intersection of Lexington-Fedor road and Giddings upper public road, 1,900 feet south of crossing of Middle Yegua Creek; iron post stamped "368 SA"	359.694
Fedor, 1,000 feet north of store, 50 feet south of forks of Lexington-Fedor and Fedor-Austin public roads; iron post stamped "424 SA"	415.742
Fedor, 2.25 miles west of, at intersection of Fedor-Austin and Giddings-Taylor public roads, 1,550 feet north of West Yegua Creek; iron post stamped "453 SA"	444.566

	Feet.
Paige, 3.5 miles north of, 40 feet northeast of intersection of roads, at gate; iron post stamped "520 SA"	511.664
Paige, 3 miles north of, 65 feet northeast of intersection of upper Lexington road and Paige-Darden Springs public road; iron post stamped "531 SA"	522.826

Bastrop to Caldwell along public roads.

Bastrop, 3 miles west of, at forks of Weberville road and abandoned road to Garfield, 3 feet from fence; iron post stamped "410"	404.680
Bastrop, 6.56 miles west of, at forks of new county road to Garfield; iron post stamped "422"	416.780
Caldwell, 100 feet northwest of, 50 feet north of Bastrop and Austin public road, via Garfield; iron post stamped "576"	570.560

Bastrop to Cedar Creek along public road.

Cedar Creek, 3.25 miles east of, forks of Bastrop and Cedar Creek road with road leading to Winson's gin, 20 feet east of 26-inch post oak tree; iron post stamped "446 SA"	437.996
Cedar Creek, 400 feet south of post office, 19 feet south of southeast fence corner at forks of Bastrop-Cedar Creek road with Austin-Port Lavaca road; iron post stamped "445 SA"	437.240

Cedar Creek southeast to Red Rock and northeast to Bastrop via public roads.

Cedar Creek, 5 miles south of, on north side of Austin and Port Lavaca road at point where road makes a sharp bend, 4 feet west of 20-inch post oak tree; iron post stamped "472 SA"	464.118
Red Rock, 4.75 miles north of, at forks of Austin and Port Lavaca road with old road to Red Rock, 0.75 mile northwest of Walnut Creek Catholic Church, 6 feet southeast of 24-inch dead post oak tree utilized as fence corner post; iron post stamped "478 SA"	470.467
Bastrop, 8.25 miles southwest of, at forks of Bastrop and Red Rock road with a settlement road, 40 feet east of fence line, 200 feet north of house with log chimney; iron post stamped "477 SA"	469.119
Bastrop, 3.25 miles southwest of, at intersection of Bastrop and Red Rock road with settlement roads, 3 feet south of northeast fence, 45 feet southeast of gate; iron post stamped "384 SA"	376.176

Bastrop via Nashs Ferry and Colorado Chapel to Sayersville.

Nashs Ferry, 300 feet north of, on east side of road, 150 feet east of right bank of Colorado River, 5 feet north of 16-inch elm tree; iron post stamped "372 SA"	363.805
Sayersville, 6 miles west of, 40 feet southeast of forks of Elgin-Coats road with Bastrop road, 800 feet northeast of Coats Bridge, over Wilbarger Creek; iron post stamped "391 SA"	383.156

Sayersville to McDade along public roads.

Sayersville, 3.25 miles northeast of, at forks of McDade and Sayersville road with Elgin road, 250 feet west of small bridge over ravine and on north side of road; iron post stamped "514 SA"	506.119
McDade, 2 miles west of, east side of McDade and Sayersville road, at bend opposite wire fence corner; iron post stamped "504 SA"	496.073

Paige to Lexington via Darden Springs, Blue, and Center Point Chapel.

	Feet.
Darden Springs, 2 miles south of, just north of Bastrop-Lee County line, at forks of Darden Springs and Paige Road with settlement road leading southwest; iron post stamped "498 SA"	489.779
Darden Springs, 8 feet east of Dr. Darden's east gatepost, on south side of road, opposite point where road turns north; iron post stamped "444 SA"	435.730
Darden Springs, 2 miles north of, at forks with settlement road; iron post stamped "499 SA"	490.744
Blue, 2 miles south of, forks of Taylor-Giddings road with private road leading southeast, 25 feet north of mileboard marked "GID. 18 mi."; iron post stamped "511 SA"	502.693
Center Point Chapel, 0.5 mile west of, southwest corner of forks of Austin-Lexington road leading south; iron post stamped "487 SA"	478.834
Center Point Chapel, 3.3 miles east of, south side of road, 10 feet east of wire fence corner, at forks of settlement road leading south; iron post stamped "397 SA"	388.895
Lexington, 2 miles west of, forks of Austin-Lexington road with Taylor-Georgetown road, 50 feet west of post oak tree utilized as milepost "Lexington 2 mi."; iron post stamped "464 SA"	455.930

Lexington to Elgin via Florence and Beaukiss.

Lexington, 5.75 miles northwest of, forks of Taylor-Georgetown road with Rockdale public road, 40 feet northeast of 4-inch post oak tree utilized as guidepost; iron post stamped "471 SA"	462.986
Florence schoolhouse, 0.5 mile east of, forks of Taylor-Georgetown road and Beaukiss "cut-off" road, 500 feet southwest of intersection with Elgin-Lexington road; iron post stamped "469 SA"	461.020
Florence schoolhouse, 2.5 miles west of, at forks of Elgin and Lexington road with crossroad to Taylor-Georgetown road, 125 feet east of right angle in road from west to south; iron post stamped "472 SA"	464.519
Beaukiss, 2.25 miles east of, at west forks of Elgin and Lexington road with Taylor and Giddings road, 5 feet southwest of milepost "14 mi. to Elgin," alongside fence line; iron post stamped "551 SA"	542.586
Beaukiss, 2.5 miles east of southeast corner of Oliver's general store and post office, on north side of Elgin and Lexington road; iron post stamped "502 SA"	493.821
Beaukiss, 3.25 miles southwest of, 200 feet southeast of Siloam schoolhouse, 8 feet east of southeast corner of forks of road; iron post stamped "497 SA"	488.779
Elgin, 5.75 miles northeast of, 10 feet southwest of northwest fence corner, at forks of Elgin and Lexington road with road to Taylor; iron post stamped "589 SA"	580.936
Elgin, 2.75 miles northeast of, 500 feet east of Redtown schoolhouse, 3 feet south of southeast fence corner at forks of Elgin and Lexington road with a public road leading east; iron post stamped "573 SA"	565.026

Elgin to Coupland along Houston & Texas Central R. R.

Coupland, in front of station, 50 feet east of main track of Missouri, Kansas & Texas Ry., 5 feet east of southwest corner of fence inclosing section-house yard; iron post stamped "526"	51[illegible]

Coupland to Rices Crossing along public road.

	Feet.
Rices Crossing, southeast corner of Rices Crossing-Byersville road with Taylor-Manor public road, 150 feet southwest of schoolhouse; iron post stamped "556 SA"	547.027

Rices Crossing south via Manda to Littig, thence via Houston & Texas Central R. R. east to Elgin.

Rices Crossing, 4 miles south of, 4 feet north of northeast fence corner post at forks of Taylor-Manor public road with a public road leading eastward; iron post stamped "528 SA"	519.138
Manda post office, 100 feet southwest of, on west side of road at intersection with road to Elgin, 25 feet south of fence corner, 100 feet southwest of Lutheran Church; iron post stamped "558 SA"	548.975
Littig, in front of station; top of rail	456.4
Littig, 800 feet east of station, 40 feet south of Houston & Texas Central R. R. track, 4 feet north of right of way fence; iron post stamped "470 SA"	462.154

Smithville to Bastrop along Missouri, Kansas & Texas Ry.

Smithville, 10 feet east of second telegraph pole south of mileboard 969; iron post stamped "329"	323.702
Upton, 45 feet east of head block south end of switch, near right of way fence, iron post stamped "349"	343.528
Hills Prairie, 28 feet east of south head block, near right of way fence; iron post stamped "359"	353.494
Bastrop, 2 miles south of, railway bridge over Colorado River; copper bolt set in masonry at east end of north bridge seat, stamped "358"	352.588

BLANCO QUADRANGLE.

Bee Caves along public roads via Round Mountain to Willow City.

Bee Caves, 3.25 miles west of, 13 feet west of fence corner post south side of road at bend in road from northeast to west; iron post stamped "1193 SA"	1,184.918
Bee Caves, 6.25 miles west of, east side of road, 10 feet north of twin elms, at corner of stone wall; iron post stamped "1120 SA"	1,111.966

Bee Caves northwest along Austin and Round Mountain public road to Round Mountain.

Bee Caves, 9 miles northwest of, at forks with a settlement road south; iron post stamped "1321 SA"	1,312.782
Cypress Mill, 10.25 miles southeast of, in top of 24 by 48 inch limestone outcrop on northeast side of road; bronze tablet stamped "921 SA"	913.261
Cypress Mill, 8 miles southeast of, west bank of Pedernales River, north side of road, 21 feet south of picket fence corner, in top of limestone outcrop; bronze tablet stamped "815 SA"	807.076
Cypress Mill, 5.25 miles southeast of, 3 feet north of cedar post at angle of fence on north side of road, 300 feet west of farmhouse; iron post stamped "928 SA"	919.953
Cypress Mill, 2.5 miles southeast of, at forks with settlement road southwest; iron post stamped "964 SA"	956.008

	Feet.
Cypress Mill, in top of limestone rock 4 feet in diameter, west side of road, 250 feet northeast of post office, 100 feet south of Cypress Creek; bronze tablet stamped "976 SA"	967.569
Cypress Mill, 3 miles northwest of, 2 feet east of telephone pole on summit of hill, north side of road; iron post stamped "1172 SA"	1,163.837
Round Mountain, 0.25 mile east of post office, 4 feet west of fence corner, 200 feet northwest of Baptist Church, at forks of road; iron post stamped "1292 SA"	1,283.997

Round Mountain northwest along public roads via Llano to Smith's ranch.

Round Mountain, 2.25 miles northwest of, 4 feet west of gate to pasture on south side of road; iron post stamped "1413 SA"	1,404.991
Round Mountain, 5 miles northwest of, northwest side of road, 18 feet southeast of telephone pole at slight bend of road; iron post stamped "1374 SA"	1,365.777
Round Mountain, 8.25 miles northwest of, at Smith's ranch, 5 feet southeast of gate southwest side of road, at intersection with Fredericksburg and Marble Falls road; iron post stamped "1171 SA"	1,162.911

Smith's ranch southwest along Fredericksburg and Marble Falls public road.

Smith's ranch, 3 miles west of, 7 feet north of gate on division fence line north side of road; iron post stamped "1149 SA"	1,140.967

BOERNE QUADRANGLE.

Ganahl to San Antonio via San Antonio & Aransas Pass Ry.

Comfort and Kerrville highway crossing, between mileboards 292 and 291, southwest corner of intersection; iron post stamped "1437"	1,428.432
Comfort, opposite side of track from northwest corner of San Antonio and Aransas Pass Ry. station; iron post stamped "1437"	1,428.630
Guadalupe River Bridge, 4.5 miles southeast of Comfort, in top of coping at southeast end of east pier; copper bolt stamped "U.S.G.S. 1374 B.M."	1,365.445
Waring, in front of station; center of track	1,355.2
Waring, 1.5 miles southeast of, crossing of Boerne and Fredericksburg highway and San Antonio & Aransas Pass Ry., 50 feet southwest of intersection; iron post stamped "1377"	1,368.193
Welfare, in front of station sign, center of track	1,399.2
Spanish Pass, 1.25 miles north of, first arch culvert north of milepost 276, also first south of negro's residence 75 feet west of railway, in cap over keystone of arch at west end of culvert; copper bolt stamped "U.S.G.S. 1535 B.M."	1,526.160
Boerne, near passenger station, 10 feet north of first telegraph pole; top of rail	1,404.054
Cibolo Creek Bridge, west end of north pier, in coping; copper bolt stamped "U.S.G.S. 1358 B.M."	1,349.351
Van Raub, opposite store; center of track	1,371.2
Van Raub, just north of station (store), 120 feet south of fourth telegraph pole south of milepost 263, 8 feet east of track, in solid rock; copper bolt stamped "U.S.G.S. 1375 B.M."	1,366.713
Aue Station, 75 feet west of track, in northeast corner of Max Aue's residence; bronze table stamped "1141"	1,132.373
Leon Creek, 15 feet south of sill of trestle 572, on south bank, 11 feet east of east rail, in solid rock; copper bolt stamped "U.S.G.S. 1036 B.M."	[illegible]

Gill's Lane southwest over Fredericksburg and Sisterdale road to Sisterdale.

	Feet.
Comfort, 7.5 miles north of, 200 feet east of Block Creek, east side of road, by stone-fence corner; iron post stamped "1453 SA"	1,444.960
Waring, 4 miles northwest of, forks of Fredericksburg-San Antonio and Fredericksburg-Sisterdale roads, 4 feet west of Sisterdale and 40 feet east of San Antonio roads, 1 foot east of north gatepost; iron post stamped "1563 SA"	1,555.243
Sisterdale, 0.2 mile west of, south side of road by wire fence, 1 foot north of big gate; iron post stamped "1447 SA"	1,439.363

John Kneupp's ranch, west over Comfort and Blanco roads to Sisterdale.

John Kneupp's ranch, 1.75 miles west of, south side of road by wire fence, in mound of stone; iron post stamped "1451 SA"	1,443.035
Davis's ranch, 10 feet west of gate, entrance to pasture, north side of road; iron post stamped "1411 SA"	1,403.106
Sisterdale, 4.25 miles east of, 2 feet west of big gate; iron post stamped "1389 SA"	1,381.0
Sisterdale, 0.5 mile southeast of, foot of hill north side of road, by rail fence, 400 feet east of stream; iron post stamped "1279 SA"	1,271.015

Point 3.5 miles north of Comfort along highway to Comfort.

Comfort, 3.5 miles north of, 10 feet north of farm gate, 600 feet west of a stone farmhouse, on west side of road; iron post stamped "1530 SA"	1,523.056
Comfort, 1.5 miles north of, north of guide post "To Cypress Creek," at northwest corner of junction with road running northwest; iron post stamped "1521 SA"	1,514.110
Comfort, opposite San Antonio & Aransas Pass Ry. station; iron post stamped "1436 SA"	1,428.630

BURNET QUADRANGLE.

Bertram to Graphite along Houston & Texas Central R. R., western division.

Bertram, 1.75 miles southeast of, on southeast side of settlement road, 43 feet southwest of track; iron post stamped "1198 SA"	1,190.134
Bertram, 120 feet southeast of station, 24 feet southwest of track on northwest side of Bertram and Brooks Mill public road; iron post stamped "1266 SA"	1,258.472
Bertram, in front of station; top of rail	1,259.6
Burnet, 3.25 miles east of, 500 feet west of head block of switch, at summit, 57 feet southwest of milepost 57, 19 feet south of main track, top of limestone outcrop; iron post stamped "1494 SA"	1,486.341
Burnet, 2 miles east of, 47 feet west of track, 17 feet south of gate at private road crossing; iron post stamped "1387 SA"	1,379.08
Burnet, 0.25 mile south of station, on southeast side of Pecan Street, 30 feet southwest of track; iron post stamped "1282 SA"	1,274.185
Burnet, in front of station; top of rail	1,285.0
Burnet, east front of county courthouse, in north end of first window sill south of entrance; bronze tablet stamped "1300 SA"	1,291.785
Burnet, 2 miles southwest of, on northwest side of Burnet and Marble Falls public road, 36 feet northeast of track; iron post stamped "1250 SA"	1,242.040

	Feet.
Fairland, 3 miles northeast of, on south side of a private road crossing 0.25 mile north of Sudduth section house, 27 feet west of track; iron post stamped "1142 SA"	1,134.072
Sudduth, in front of section house; top of rail	1,135.4
Fairland, east side of station; top of rail	964.5
Fairland, 70 feet southwest of Marble Falls branch track, on southeast side of Burnet and Fredericksburg public road; iron post stamped "953 SA"	945.269
Fairland, 3 miles southwest of, on east side of Burnet and Fredericksburg road crossing, near right of way fence corner, 44 feet south of track; iron post stamped "992 SA"	984.040
Kingsland, 3 miles southeast of, on north side of public road, 52 feet south of track and 110 feet west of trestle 760; iron post stamped "881 SA"	873.329
Kingsland, in front of station; top of rail	848.3
Kingsland, near southwest corner of small park opposite station, 21 feet north of main track; iron post stamped "856 SA"	848.298
Kingsland, 3 miles northwest of, at forks of old Fort Mason, Kingsland, and Llano roads, 70 feet west of track, 23 feet north of twin elm tree utilized as milepost "Kingsland 3.5 miles;" iron post stamped "954 SA"	945.452
Kingsland, 5.5 miles northwest of, on west side of settlement road, 0.25 mile southeast of bridge 85 B over Sandy Creek, 27 feet southwest of track; iron post stamped "914 SA"	905.536

Smith's ranch to Marble Falls along Fredericksburg and Marble Falls road.

Smith's ranch, 3 miles northeast of, 200 feet southwest of Bridge's farmhouse, 6 feet south of gate on south side of road; iron post stamped "979 SA"	970.865
Smith's ranch, 6 miles northeast of, 25 feet southwest of road, 35 feet northwest of Slick Rock Creek; iron post stamped "834 SA"	825.921
Marble Falls, 4.25 miles southwest of, on north side of road by wire fence, 5 feet south of 15-inch post oak tree utilized as a gate post; iron post stamped "827 SA"	818.883
Marble Falls, 0.5 mile southwest of, in top of limestone outcrop 7 feet southeast of road, 250 feet southwest of bridge over Colorado River, 50 feet northeast of forks of road; aluminum tablet stamped "790 SA"	781.962
Marble Falls, at southeast corner of park, 60 feet northeast of northeast corner of Houston & Texas Central Railroad station; iron post stamped "764 SA"	755.929

Marble Falls to Fairland along Houston & Texas Central R. R., western division.

Marble Falls, in front of station; top of rail	755.6
Granite Mountain, in front of station; top of rail	857.8
Fairland, 2 miles south of, 600 feet north of milepost 73, 50 feet east of track, at right of way fence corner on north side of settlement road; iron post stamped "897 SA"	889.007

Milepost 15, on Houston & Texas Central R. R., 3 miles northwest of Kingsland, east along public road via Mason Crossing to Burnet.

	Feet.
Mason Crossing, west bank of Colorado River, 59 feet southwest of road at bend; iron post stamped "834 SA"	825.847
Mason Crossing, 2.75 miles northeast of, at junction of old Fort Mason, Marble Falls, and Bluffton roads, 200 feet south of Moore's store; iron post stamped "883 SA"	874.888
Mason Crossing, 5.5 miles northeast of, southeast side of road by a live oak tree, 50 feet northeast of milestone "8 M;" iron post stamped "1261 SA"	1,252.950
Burnet, 5 miles west of, on south side of road by wire fence, 6 feet west of milestone "B 5;" iron post stamped "1390 SA"	1,381.573
Burnet, 2.25 miles west of, at junction of old Fort Mason-Burnet road and Bluffton road; iron post stamped "1403 SA"	1,394.437

Burnet along public roads via Pomona post office to Naruna.

Burnet, 3 miles north of, 300 feet north of junction of Burnet-Lampasas and Burnet, Brooks Mill, and Lampasas roads, by wire fence on northeast side of road; iron post stamped "1449 SA"	1,440.946
Burnet, 6.33 miles north of, on west side of road, 9 feet south of gate at Boyd's ranch; iron post stamped "1480 SA"	1,472.294
Burnet, 9 miles north of, on west side of road at intersection with settlement road running northwest and southeast; iron post stamped "1510 SA"	1,501.654
Naruna, 6.5 miles southeast of, west side of road on summit of hill at junction of Burnet-Lampasas and Austin-San Saba roads, 700 feet northeast of Pomona post office; iron post stamped "1466 SA"	1,457.905
Naruna, 4.5 miles southeast of, at junction with settlement road running north, 750 feet southeast of old railroad grade, 50 feet northwest of southwest fence corner; iron post stamped "1468 SA"	1,460.138
Naruna, 2.5 miles southeast of, 700 feet southeast of Littlepage's residence, 20 feet north of south fence line opposite angle in road, in top of limestone outcrop; bronze tablet stamped "1500 SA"	1,491.881
Naruna, 170 feet southeast of Baptist Church, at intersection of Austin-San Saba and Llano-Lampasas roads, iron post stamped "1476 SA"	1,467.965

Naruna along public and settlement roads to Bluffton.

Naruna, 3 miles southwest of, on north side of 18-inch post oak tree in middle of lane, west side of road at bend, in top of limestone outcrop; aluminum tablet stamped "1455 SA"	1,447.307

Southward along settlement road.

Naruna, 6 miles southwest of, 80 feet west of small drain, 25 feet northwest of blazed 12-inch post oak tree, 15 feet south of road, in top of limestone outcrop; bronze tablet stamped "1457 SA"	1,449.240

Southwest along Bluffton and Lampasas road.

Bluffton, 4.66 miles northeast of, at high point in open pasture, 15 feet southeast of road, in top of limestone outcrop; aluminum tablet stamped "1399 SA"	1,390.845

	Feet.
Bluffton, 1.66 miles northeast of, 100 feet northeast of gate, 30 feet north of 6-inch blazed live oak tree, on rocky hillside 35 feet west of road, in red sandstone outcrop; aluminum tablet stamped "1006 SA"	998.004
Bluffton, 7 feet east of northeast fence corner, at junction of Burnet-Llano and Bluffton-Lampasas roads; iron post stamped "1012 SA"	1,004.089

Bluffton southeast along Burnet and Llano road to Burnet.

Bluffton, 1.25 miles southeast of, northeast side of road at junction with road running to McDonald's mill, 200 feet southeast of southeast bank of Colorado River; iron post stamped "948 SA"	940.134
Bluffton, 4.25 miles southeast of, 10 feet east of 18-inch post oak tree utilized as fence post at angle on north side of road; iron post stamped "1227 SA"	1,219.086
Burnet, 6 miles northwest of, at junction with settlement road running west, on southwest side of road, in top of pink granite outcrop; aluminum tablet stamped "1285 SA"	1,277.111

Burnet northeast along Burnet, Brooks Mill, and Lampasas road to Sage.

Burnet, 5.75 miles northeast of, west side of road at junction with settlement road running northwest, 200 feet south of summit of hill; iron post stamped "1454 SA"	1,446.129
Sage, 1.75 miles southwest of, 7 feet south of fence corner at right angle bend of road, 250 feet east of Bethel schoolhouse; iron post stamped "1346 SA"	1,338.097
Sage, 250 feet south of post office, 75 feet south of north fork of San Gabriel River, opposite Murphy & Jenkin's gin, in top of limestone bowlder; aluminum tablet stamped "1261 SA"	1,252.910

Sage along public roads via Sunny Lane to Bachelor Peak.

Sunny Lane, 250 feet southwest of post office, in top of embedded limestone bowlder, by wire fence corner, on north side of road, 150 feet northeast of Methodist Church, at junction of Burnet, Brooks Mill, and Lampasas road and Austin road; aluminum tablet stamped "1168 SA"	1,160.517
Sunny Lane, 2.5 miles north of, south side of gate on west side of road, at junction with settlement road running to Bachelor Peak; iron post stamped "1335 SA"	1,327.013

Northeast along settlement road via Eldridge & Field's ranch to Georgetown and Lampasas road.

Bachelor Peak, 0.5 mile southeast of, 200 feet southeast of junction with settlement road running southwest to Eldridge & Field's ranch, in top of limestone rock on southwest fence line of Georgetown and Lampasas road; aluminum tablet stamped "1260 SA"	1,251.891

Bachelor Peak along public roads to Joppa.

Bachelor Peak, 3.5 miles southeast of, 220 feet northwest of bridge over small drain, on northeast side of road, in top of limestone bowlder, by stone wall; aluminum tablet stamped "1125 SA"	1,117.138
Bachelor Peak, 6 miles southeast of, 0.5 mile southwest of North Rocky Creek, in top of embedded limestone rock, * feet north of gate on west side of road, at junction with settlement road running southwest; aluminum tablet stamped "1018 SA"	1,009.502

Southwest along settlement road through Cook's pasture, thence southwest along Burnet and Belton road.

	Feet.
Neely's ranch, 1.5 miles northeast of, on southeast bank of South Rocky Creek, in top of limestone ledge on northeast side of road; aluminum tablet stamped "972 SA"	963.210
Neely's ranch, 2 miles southwest of, 10 feet east of gate at junction with settlement road running south to Joppa, in top of embedded limestone rock; aluminum tablet stamped "1251 SA"	1,243.151
Joppa, 110 feet northeast of schoolhouse, in top of limestone rock at junction of Burnet and Florence road with settlement road; aluminum tablet stamped "1106 SA"	1,098.315

Joppa southwest along Burnet and Florence road to Burnet.

Joppa, 2.5 miles southwest of, northwest side of road by wire fence at junction with Burnet and Belton road; iron post stamped "1230 SA"	1,221.816
Joppa, 5.5 miles southwest of, north side of road opposite fence dividing two cultivated fields at summit of hill; iron post stamped "1299 SA"	1,290.930
Burnet, 4.75 miles northeast of, north side of road, 4 feet west of 12-inch elm tree utilized as fence corner post, on northwest bank of Russell Fork, San Gabriel River; iron post stamped "1273 SA"	1,264.781
Burnet, 2.5 miles northeast of, 300 feet northwest of farmhouse, at fence corner on southeast side of road; iron post stamped "1441 SA"	1,433.717

Bluffton along public roads to Tow.

Bluffton, 2 miles west of, at junction of Burnet and Llano and Bluffton and San Saba roads; iron post stamped "1027 SA"	1,019.113
Tow, 2 miles southeast of, on northeast side of road at intersection of settlement road; iron post stamped "1034 SA"	1,026.126
Tow, northeast corner of post office, at junction with settlement road running west, 400 feet northwest of schoolhouse; iron post stamped "1025 SA"	1,017.000

Tow along Bluffton and San Saba road to Beyt's ranch.

Tow, 3.5 miles northwest of, south bank of Falls Creek, in bench of limestone bluff 3 feet above ground on west side of road; aluminum tablet stamped "1166 SA"	1,158.434
Ramsey's ranch, in top of limestone bowlder 5 feet northeast of gate, 70 feet east of Ramsey's residence; bronze tablet stamped "1368 SA"	1,360.199

Along Burnet and Llano road from point 2 miles west of Bluffton.

Bluffton, 5 miles west of, by rail fence at northwest corner of cultivated field, south side of road; iron post stamped "1084 SA"	1,075.971

Burnet along road to Morman Mill.

Burnet, 3.5 miles south of, 300 feet northwest of white farmhouse with green blinds, on east side of road; iron post stamped "1230 SA"	1,222.227
Burnet, 6 miles south of, on southeast bank of Hairston Creek, 20 feet southwest of road; iron post stamped "1044 SA"	1,036.245

	Feet.
Morman Mill, on east side of road at junction with road running southwest to Morman Mill, about 200 yards distant; iron post stamped "839 SA"	831.356

Morman Mill along public roads to Marble Falls.

Hale Spring Church, 100 feet southeast of, by picket fence corner on southwest side of road near northeast corner of arbor; iron post stamped "750 SA"	742.415

Westward along Marble Falls and Smithwick road.

Marble Falls, 3.5 miles east of, by corner of rail fence around cultivated field, 120 feet southeast of Pleasant Valley schoolhouse, on northwest side of road; iron post stamped "795 SA"	787.237

East along Marble and Smithwick road to Smithwick.

Marble Falls, 5 miles east of, by rail fence on southwest side of road, at junction of Marble Falls-Smithwick and Burnet-Morman Mill roads, about 0.25 mile northeast of Pangle crossing of Colorado River; iron post stamped "732 SA"	724.247
Smithwick, 2 miles northwest of, at intersection of Marble Falls-Smithwick, Marble Falls-Georgetown, and Burnet-Smithwick roads; iron post stamped "900 SA"	892.163
Smithwick, at northeast corner of post office and store on west side of road; iron post stamped "727 SA"	719.222

Smithwick along public roads via Hall's ranch to Spanish Creek.

Smithwick, 3.75 miles northeast of, 60 feet southeast of intersection of Smithwick, Bagdad, Burnet, and Corwin roads; iron post stamped "842 SA"	834.268

Southeast along Burnet and Corwin road.

Hall's ranch, 1.5 miles northwest of, in top of ledge northeast side of road on east side of creek, at point where road makes horseshoe bend; aluminum tablet stamped "797 SA"	789.496

Spanish Creek along public road and settlement road to Cow Creek.

Travis Peak, 3.75 miles northwest of, 10 feet south of road on top of hill; iron post stamped "1098 SA"	1,090.365
Travis Peak, 1 mile northwest of, at junction of Burnet and Austin road with settlement road running northeast to Cow Creek, 50 feet southeast of forks; iron post stamped "858 SA"	850.489

North along settlement road up Cow Creek.

Travis Peak, 4 miles north of, in top of limestone bowlder on southwest side of road, on west bank of Crow Creek; bronze tablet stamped "855 SA"	847.500
Travis Peak, 7 miles north of, 100 feet southeast of point where road crosses Cow Creek, 20 feet south of road; iron post stamped "947 SA"	939.240

Cow Creek northeast along Smithwick and Bagdad road to Wilk's ranch.

	Feet.
Wilk's ranch, 2 miles southwest of, northwest side of road at junction with settlement road running southwest, 350 feet northeast of milestone 16; iron post stamped "1142 SA"	1,134.169

Wilk's ranch along South Gabriel and McNew road to Bertram.

Bertram, 7.5 miles south of, in forks of roads at junction with settlement road running southeast; iron post stamped "1358 SA"	1,350.095
Bertram, 3.5 miles south of, on west side of road and south bank of Oatmeal Creek; iron post stamped "1137 SA"	1,129.230

FLATONIA QUADRANGLE.

Red Rock via Smithville to West Point along Missouri, Kansas & Texas Ry.

Red Rock, 1,200 feet south of Missouri, Kansas & Texas Ry. passenger station, 125 feet south of track, at intersection of the Waelder and Red Rock and Rosanky public roads; iron post stamped "491 SA"	482.749
Red Rock, 6 miles east of, 4 miles west of Rosanky, 1,100 feet east of section house, 45 feet southwest of settlement road crossing and about half way between mileboards 983 and 984; iron post stamped "451 SA"	442.729
Rosanky, 120 yards west of railroad station, 50 feet south of crossing of Rosanky and Jeddo public roads; iron post stamped "512 SA"	504.338
Smithville, 4.5 miles southwest of, second telegraph pole east of milepost 974, corner of fence, 65 feet northeast of road crossing; iron post stamped "460 SA"	452.527
Smithville, 2.5 miles southwest of, mileboard 972, 0.25 mile east of, 25 feet northwest of road crossing; iron post stamped "433 SA"	425.386
Primm, back of second telegraph pole east of milepost 974, near right of way fence; iron post stamped "316"	310.618
West Point, in corner of right of way fence, 90 feet west and 40 feet north of junction at crossing of San Antonio & Aransas Pass Ry. and Missouri, Kansas & Texas Ry	286.626

West Point south along Waco branch of San Antonio & Aransas Pass Ry. to Henkhaus.

Muldoon, 3.5 miles northeast of, in solid rock, 30 feet north of trestle 128, 35 feet west of west rail; bronze tablet stamped "316"	310.376
Lean spur, opposite signboard; top of tie	314.0
Muldoon, in southwest corner of A. B. Kerr & Son's store; bronze tablet stamped "351"	345.370
Muldoon, 4.5 miles southwest of, 10 feet north of mileboard 153; iron post stamped "362"	356.588
McCammon, opposite signboard; center of track	390.0
Flatonia, crossing of Galveston, Harrisburg & San Antonio Ry. and San Antonio & Aransas Pass Ry., tracks on south side of Galveston, Harrisburg & San Antonio tracks; iron post stamped "473"	457.500
Flatonia, 4.5 miles south of, second telegraph pole south of mile board 143; crossing of Gonzales and Flatonia public road via Old Moulton, in northwest corner of right of way fence, 700 feet east of Lavaca River; iron post stamped "448 SA"	439.990

	Feet.
Moulton, 600 feet north of passenger station; crossing of the Flatonia and Moulton public road, in northwest corner of right of way fence; iron post stamped "391 SA"	383.058
Henkhaus, 800 feet north of store, east side of New Moulton and Shiner road, 12 feet south of corner of fence, at mouth of lane that oges to Witting, 100 feet east of San Antonio & Aransas Pass Ry., about 0.5 mile south of mile board 135; iron post stamped "403 SA"	395.072

Engle west along Galveston, Harrisburg & San Antonio Ry. to Harwood.

Engle, 200 feet northwest of station, 20 feet northwest of road crossing and 15 feet north of center of main track of Galveston, Harrisburg & San Antonio Ry; iron post stamped "374 SA"	366.124
Flatonia, 2.75 miles west of, 0.5 mile west of mile board 123, southeast corner of right of way fence at crossing of Flatonia and Gonzales public road, at cattle guard 296, Galveston, Harrisburg & San Antonio Ry.; iron post stamped "392 SA"	384.088
Pierson, east end of siding, south of head block, 1.5 feet from wire fence (fence may have been moved back); iron post stamped "337"	321.829
Waelder, at west end of small park east of station, 30 feet north of track; iron post stamped "386"	370.493
Dry Branch, 4.25 miles west of Waelder, iron girder span 251; in rock pedestal of west concrete pier; bronze tablet stamped "374"	358.259
Sandy Fork, in northwest corner of rock under post, north end of west brick pier; copper bolt stamped "U.S.G.S. 370 B.M."	354.976

Gonzales to Harwood along Gonzales branch, Galveston, Harrisburg & San Antonio Ry.

Gonzales, 3.25 miles north of, 1.5 miles south of section house 206, 25 feet east of track, 6 feet west of southwest corner of iron fence inclosing cemetery, halfway between mile boards 8 and 9; iron post stamped "393 SA"	384.813
Kokernot, 12 feet south of north switch stand, 15 feet east of main track, midway between eighth and ninth telegraph poles north of milepost 6; iron post stamped "406 SA"	397.760
Harwood, 2 miles south of, near mile board 2, 50 feet east of head block at wood spur, corner of fence at road crossing, 150 feet northeast of settlement; iron post stamped "441 SA"	432.776

Red Rock via Delhi to Harwood along public roads.

Red Rock, 4.5 miles south of, forks of Waelder and Austin public road and a settlement road leading to Hoy Spring, just southeast of house; iron post stamped "565 SA"	556.890
Delhi, 40 feet northeast of the crossing of Lagrange-Lockhart and Waelder-Austin public roads; iron post stamped "535 SA"	527.013
Delhi, 4.75 miles southwest of, forks of Delhi-Harwood and Delhi-Thompsonville settlement roads; iron post stamped "500 SA"	491.995
Delhi, 8.5 miles southwest of, 100 feet west of forks of public road to Lockhart and a settlement road to Luling; iron post stamped "515 SA"	507.105
Harwood, 4.12 miles north of, 25 feet northwest of the crossing of the Waelder and Lockhart public road via Thompsonville; iron post stamped "460 SA"	452.082

Sandy Fork, on Galveston, Harrisburg & San Antonio Ry., north along public roads to Rosanky.

	Feet.
Sandy Fork, 3.5 miles northeast of, crossing of Gonzales-Lockhart-Harwood and Waelder public roads; iron post stamped "432 SA"	424.008
Sandy Fork, 7.5 miles northeast of, forks of road 300 feet south of Henry Gunn's residence; iron post stamped "455 SA"	447.070
Jeddo, 2 miles south of, intersection of Waelder and Bastrop and settlement roads, 7 miles northwest of Waelder; iron post stamped "484 SA"	476.045
Jeddo, 400 feet southeast of, intersection of settlement road and Lagrange and Lockhart road; iron post stamped "455 SA"	447.034
Jeddo, 1.5 miles west of, 25 feet north of the crossing of the Waelder-Bastrop and Lagrange-Lockhart public roads, 1.25 miles west of Jeddo, 4.5 miles east of Delhi; iron post stamped "536 SA"	528.157
Rosanky, 5.75 miles south of, 45 feet southwest of forks of road, 1 mile north of Peach Creek; iron post stamped "516 SA"	508.266
Rosanky, 1.5 miles southwest of, 20 feet northeast of intersection of Waelder-Bastrop and Austin-Port Lavaca public roads; iron post stamped "468 SA"	460.215

Jeddo northeast along public roads to Bohemian Catholic Church and Missouri, Kansas & Texas Ry.

Jeddo, 2.5 miles northeast of, 175 feet south of I. B. Holland's residence, 6 feet west of road; iron post stamped "460 SA"	452.254
Jeddo, 8.5 miles northeast of, intersection of settlement road and Austin and Port Lavaca public road, opposite mile board 4 miles northwest of Cistern; iron post stamped "474 CSA"	466.180
Bohemian Catholic Church, one-sixth mile west of, 40 feet south of intersection of lanes and 5 feet south of leaning post-oak tree; iron post stamped "472 SA"	463.861

Jeddo to Cistern along public roads.

Jeddo, 3 miles east of, intersection of Lagrange and Lockhart with settlement road leading southwest, 35 feet south of wire fence; iron post stamped "454 SA"	446.206
Cistern, fence corner opposite post office; iron post stamped "481 SA"	473.007

Cistern to Smithville via public roads.

Cistern, 4.25 miles north of, summit of divide between Live Oak and Buckner Creeks, west side of lane, 2 feet east of wire fence; iron post stamped "481 SA"	473.086
Cistern, 9.25 miles north of, forks of Cistern and Smithville public road and settlement road; iron post stamped "416 SA"	408.185
Smithville, 3 miles south of, 400 feet southeast of intersection of Flatonia-Smithville and Cistern-Smithville public roads, 10 feet west of Flatonia road and 60 feet east of Cistern road; iron post stamped "393 SA"	385.125

Cistern to Primm, on Missouri, Kansas & Texas Ry.

Cistern, 4 miles northeast of, intersection of roads, 10 feet north of gate entrance to east side of Cockerell's pasture and 30 feet south of mouth of lane; iron post stamped "422 SA"	413.820

	Feet.
Stellar, 2.5 miles south of, 200 feet north of Buckner Creek, intersection of Smithville-Flatonia and Lagrange-Lockhart public roads; iron post stamped "349 SA"	341.087
Stellar, 3.5 miles northeast of, corner of fence at intersection of roads 25 feet southeast of Lagrange-Lockhart and Smithville-Muldoon public roads, 16 miles southwest of Lagrange; iron post stamped "404 SA"	395.938
Primm, 1.5 miles southeast of, forks of Smithville-West Point road with public road to Muldoon and Flatonia, 0.75 mile south of milepost 975; iron post stamped "322 SA"	313.906

Flatonia to Smithville along public roads.

Flatonia, 5 miles north of, intersection of Smithville, Muldoon, and Flatonia public roads, 5.5 miles southwest of Muldoon, 1,000 feet north of Pin Oak Creek; iron post stamped "377 SA"	369.288
Dogwood Creek, 1,200 feet north of, 125 feet north of branch 15 feet east of road; iron post stamped "357 SA"	349.188
Stellar, 3.25 miles north of, angle of wire fence 35 feet east of road, 12 feet west of post-oak tree used as fence post; iron post stamped "428 SA"	420.018

Waelder to Cistern via public roads.

Waelder, 3.75 miles northwest of, forks of Bastrop and Lockhart public roads, 700 feet north of 2-story house, 10 feet north of gate; iron post stamped "475 SA"	466.576
Waelder, 4.5 miles northeast of, 20 feet south of double live oak trees, intersection of Waelder and Jeddo public roads, southeast corner of wire fence; iron post stamped "444 SA"	436.408
Cistern, 5 miles southwest of, 150 feet south of Elm Grove Church, 50 feet east of schoolhouse, 25 feet northeast of the intersection of a third-class road; iron post stamped "372 SA"	364.235

Flatonia to Elm Grove Church via public roads.

Flatonia, 3.25 miles northwest of, 80 feet west of wooden bridge over Five Mile Creek, 15 feet south of road; iron post stamped "351 SA"	342.961
Elm Grove Church, 3.5 miles southeast of, forks of road, 150 feet south of mouth of lane; iron post stamped "360 SA"	352.002

Flatonia to Cistern via Colony.

Flatonia, 4.5 miles northwest of, west side of forks of road, 3 feet west of wire fence and 40 feet north of intersection of roads, 200 feet west of Martin McAnally's residence; iron post stamped "425 SA"	416.932
Colony post office, 0.5 mile south of, intersection of Flatonia-Cistern road and a public road connecting with Flatonia-Waelder public road, about 400 feet north of John Malony's frame house; iron post stamped "435 SA"	427.084

Moulton to Gonzales via public roads.

Moulton, 3.5 miles southwest of, intersection of Flatonia and Gonzales road via Old Moulton, about 0.25 mile north of White's cotton gin; iron post stamped "475 SA"	467.022
Nickel, 600 feet south of post office, at forks of Moulton-Gonzales and Nickel-Dilworth public roads; iron post stamped "446 SA"	437.909

	Feet.
Nickel, 3.5 miles southwest of, 20 feet south of road, 3 feet north of wire fence at brow of hill east of Peach Creek, 400 feet southwest of Jeff Hull's residence; iron post stamped "359 SA"	350.938
Nickel, 5.5 miles southwest of, 100 feet northwest of Peach Creek, in forks of road; iron post stamped "269 SA"	260.892
Gonzales, 7 miles northeast of, 0.75 mile west of Denton Creek; iron post stamped "313 SA"	304.941
Gonzales, 2.75 miles northeast of, 50 feet northwest of crossing of Lockhart branch of San Antonio & Aransas Pass Ry. and Moulton-Gonzales public road; iron post stamped "336 SA"	327.855
Gonzales, 75 feet west of station, 50 feet southwest of crossing of North Avenue, 50 feet south of main track; iron post stamped "306 SA"	297.738

Gonzales north along public roads to mile board 137, Galveston, Harrisburg & San Antonio Ry., near Thompsonville.

Gonzales, 5 feet east of north entrance to courthouse, in rock over basement window; bronze tablet stamped "299 SA"	291.011
Gonzales, 2.75 miles north of, brow of ridge, east side of road, 1.5 feet west of wire fence, 10 feet north of gate 400 feet south of branch; iron post stamped "359 SA"	351.168
Gonzales, 6 miles north of, at forks of Gonzales-Thompsonville road and Gonzales-Sandy Fork road; iron post stamped "419 SA"	411.105
Mile board 137, 7 miles south of, summit of ridge about 0.5 mile south of branch, 2 feet east of west line of wire fence in lane; iron post stamped "421 SA"	413.120
Mile board 137, 2.75 miles south of, intersection of Bastrop-Gonzales and Harwood-Waelder public roads, 6 miles west of Waelder and 12 miles north of Gonzales; iron post stamped "358 SA"	350.041
Mile board 137, 1.5 miles south of, intersection of roads, 20 feet east of center of public road, 6 feet south of corner of fence, 100 feet northeast of B. A. Eversole's residence; iron post stamped "359.5 SA"	351.515

Gonzales to Waelder along public roads.

Gonzales, 3 miles northeast of, intersection of roads, southeast corner of wire fence at private road 0.5 mile northeast of Carr Creek; iron post stamped "338 SA	330.066
Gonzales, 8 miles northeast of, intersection of roads, 125 feet northwest of mouth of lane about 0.75 mile northeast of Denton Creek; iron post stamped "341 SA"	332.923
Possumtrot, intersection of roads, 150 feet southwest of abandoned store, 250 feet southeast of cotton gin, 7 miles southwest of Waelder; iron post stamped "330 SA"	321.895
Waelder, 3 miles southwest of, intersection of roads, west side of main road, 1 mile northeast of Pecan Creek; iron post stamped "373 SA"	364.946

Possumtrot northeast to mile board 123, Galveston, Harrisburg & San Antonio Ry., 2.75 miles west of Flatonia.

Possumtrot, 1.75 miles northeast of, 50 feet west of Sandy Fork, and on west bank 2 feet south of fence, on north side of road, 400 feet east of foot of ridge; iron post stamped "297 SA"	289.099

	Feet.
Winnfield's gin, 2 miles southwest of, 150 feet west of branch, 25 feet north of road, 2 feet south of wire fence; iron post stamped "348 SA"	340.138
Winnfield's gin, 100 feet southeast of, intersection of Flatonia and Gonzales road via Possumtrot with Moulton-Waelder road, 75 feet west of Moulton road; iron post stamped "330 SA"	322.038
Winnfield's gin, 1.5 miles southeast of, intersection of Waelder-Moulton and Gonzales-Flatonia (via Possumtrot) roads, 0.75 mile southeast of Peach Creek; iron post stamped "299 SA"	290.886
Winnfield's gin, 2.5 miles southeast of, intersection of roads, 2 feet east of wire fence, 25 feet north of gate to settlement road west, intersecting the Moulton and Waelder road about 1.5 miles west; iron post stamped "330 SA"	322.104

Moulton to Winnfield's gin.

Old Moulton, intersection of the Waelder and Moulton public road and a road that connects with the Waelder and Moulton road and the Gonzales and Flatonia road, west side of public square; iron post stamped "436 SA"	427.917

Nickel south and east to Henkhaus via Bailey triangulation station.

Nickel, 5 miles south of, Bailey triangulation station; iron post set for triangulation point, stamped "595 SA"	586.659
Bailey triangulation station, 3.5 miles east of, on east side of old public road, 15 feet south of gate entrance to pasture, settlement road, leading to Witting, about 300 feet east of Bill Dixon's residence; iron post stamped "516 SA"	508.033

Henkhaus east and north via Witting to Engle on Galveston, Harrisburg & San Antonio Ry.

Witting post office, 0.5 mile northwest of, intersection of Hallettsville-Moulton and Witting-Flatonia public roads, near signboard marked "Hallettsville 11 miles, Breslau 5 miles, Moulton 7 miles, Flatonia 15 miles"; iron post stamped "396 SA"	388.051
Witting, 4.75 miles northeast of, forks of Flatonia and Moravia public roads; iron post stamped "363 SA"	355.081
Engle, 4 miles south of, near line dividing Lavaca and Fayette Counties, at intersection of Hallettsville-Flatonia and Schulenburg-Flatonia public roads with road to Engle; iron post stamped "411 SA"	403.088

San Antonio & Aransas Pass Ry. bridge 81 along track to Gonzales.

Slayden, 5.2 miles southeast of, southeast corner of private road crossing; iron post stamped "292"	292.217
Gonzales, 75 feet west of station, 50 feet southwest of crossing of North Avenue, 50 feet south of main track; iron post stamped "306 SA"	297.738

FREDERICKSBURG QUADRANGLE.

Oxford to Fredericksburg along public roads.

Oxford, 9 miles south of, east side of road, at junction of road east, 10 feet north of 18-inch post-oak tree utilized as gatepost; iron post stamped "1287 SA"	1,279.787

	Feet.
Oxford, 12.5 miles south of, east side of road, on west slope of Bell Mountain, at summit of hill; iron post stamped "1851 SA"	1,842.851
Fredericksburg, 14.5 miles northeast of, 12 feet west of southwest fence corner, at junction with Willow City and Llano road; iron post stamped "1749 SA"	1,741.677
Fredericksburg, 12.25 miles northeast of, 8 feet north of northwest fence corner, at junction with Burnet and Fredericksburg public road; iron post stamped "1826 SA"	1,818.774
Fredericksburg, 9.5 miles northeast of, on northwest side of road by wire fence, 27 feet northwest of 14-inch post-oak tree at fence angle; iron post stamped "1953 SA"	1,945.842
Fredericksburg, 6.5 miles northeast of, on west side of road, 60 feet east of gate at Grobe's farm, 4 feet west of 15-inch post-oak tree utilized as fence corner; iron post stamped "1724 SA"	1,716.819
Fredericksburg, 4.5 miles northeast of, 18 feet north of fence corner at angle in road, 650 feet northeast of Palo Alto Creek; iron post stamped "1649 SA"	1,641.799
Fredericksburg, 2.75 miles northeast of, at forks with a settlement road running northward, 8 feet northeast of northeast fence corner; iron post stamped "1824 SA"	1,816.817
Fredericksburg, southeast of county courthouse, in stone trimming at at corner of projection, 7 feet northeast of entrance; bronze tablet stamped "1708 SA"	1,700.864
Fredericksburg, northwest side of Fredericksburg and Comfort public road, 55 feet southwest of principal street; iron post stamped "1695 SA"	1,687.942

Fredericksburg to Comfort along Fredericksburg and Comfort road.

Fredericksburg, 4.5 miles south of, on north side of road, 4 feet west of fence post at slight angle, on north bank of Pedernales River; iron post stamped "1609 SA"	1,601.920
Fredericksburg, 6.5 miles south of, on summit of hill 15 feet south of twin scrub pin-oak tree, 3 feet east of west fence line of road; iron post stamped "1779 SA"	1,771.986
Fredericksburg, 9 miles south of, 2 feet northeast of fence corner post on west side of road, 105 feet south of 9-mile post; iron post stamped "1865 SA"	1,857.841
Comfort, 11.5 miles north of, 7 feet east of 22-inch dead post-oak tree utilized as a fence corner post at right-angle bend in road from east to south; iron post stamped "1976 SA"	1,968.747
Comfort, 9.5 miles north of, on west side of road, 7 feet north of gate; iron post stamped "2094 SA"	2,086.955

Gobe's ranch, 6.5 miles northeast of Fredericksburg, over Johnson City and Marble Falls road via Grape Creek and Key's ranch to Althouse's ranch.

Gobe's ranch, 3.5 miles southeast of, 15 feet northeast of intersection of roads, 40 feet south of gate; iron post stamped "1674 SA"	1,666.089
Gobe's ranch, 7 miles east of, foot of hill, corner of fence north of road, 120 feet west of dry creek; iron post stamped "1628 SA"	1,620.037
Gobe's ranch, 10.5 miles east of, north of road at entrance to Nebgen's ranch; iron post stamped "1718 SA"	1,710.327
Whitman Gap, Brushy Mountain, 14 miles east of Gobes ranch, at forks of road; iron post stamped "1742 SA"	1,734.092

	Feet.
Sultemier's ranch, 0.3 mile southwest of, at fork of Johnson City and Grape Creek road; iron post stamped "1646 SA"	1,638.101
Hobart's and Eckart's pastures, on line between, 25 feet east of road; iron post stamped "1427 SA"	1,418.625
Blowout, 3.75 miles southwest of, 3 feet south of mailbox post at forks of roads; iron post stamped "1544 SA"	1,535.742

Whitman Gap and Brushy Mountain via Albert to Fredericksburg.

Whitman Gap, 4 miles south of, forks of road; iron post stamped "1474 SA"	1,466.065
Albert, 0.3 mile northwest of post office, at forks of road; iron post stamped "1482 SA"	1,474.024
Albert, 3 miles west of, 500 feet southwest of Hitchfield house; iron post stamped "1599 SA"	1,591.142
Albert, 6 miles west of, at milestone 13, south side of road; iron post stamped "1493 SA"	1,485.116
Fredericksburg, 10 miles east of, at intersection of Austin and Fredericksburg road with Grape Creek and Luckenbach road, north side of road, 200 feet west of milestone 10; iron post stamped "1516 SA"	1,508.305
Fredericksburg, 7 miles east of, 500 feet north of Millening stone house; iron post stamped "1577 SA"	1,568.958

Luckenbach over Blanco road to Albert.

Luckenbach, 600 feet west of post office, forks of Comfort and Fredericksburg road; iron post stamped "1567 SA"	1,559.360
Luckenbach, 3.7 miles east of, corner of wire fence on north side of road; iron post stamped "1687 SA"	1,679.187
Luckenbach, 7.5 miles southeast of, large rock on north edge of road, 1 mile south of county line; aluminum tablet stamped "1893 SA"	1,884.992
Blanco, 12 miles west of, south side of road, 175 feet east of milestone 12; iron post stamped "1657 SA"	1,649.103
Blanco, 9 miles west of, southeast corner of yard of Weber's house; iron post stamped "1517 SA"	1,509.373
Albert, 4.2 miles southeast of, summit of divide between Pedernales and Blanco Rivers, west side of road; iron post stamped "1839 SA"	1,831.438

Luckenbach over Luckenbach-Comfort road to point 9.5 miles north of Comfort.

Luckenbach, 5 miles west of, intersection of Fredericksburg, San Antonio and Luckenbach roads; iron post stamped "1784 SA"	1,776.153
Luckenbach, 10.7 miles southwest of, at lane to Gill's ranch; iron post stamped "1611 SA"	1,602.920
Luckenbach, 14.5 miles southwest of, 800 feet south of Alfred Gill's house; iron post stamped "1703 SA"	1,695.101

Sisterdale north to Luckenbach-Blanco road.

Sisterdale, 5 miles north of, west edge of road, by wire fence; iron post stamped "1472 SA"	1,464.211
Sisterdale, 9 miles north of, summit of divide between Blanco River and Sisterdale Creek, 4 feet west of road and 50 feet north of 6-inch live-oak tree; iron post stamped "1969 SA"	1,961.203

Peter Weber's ranch along Kendalia and Albert road to John Kneupp's ranch.

	Feet.
Weber's ranch, 3 miles south of, northeast side of road, 20 feet north of big gate, at angle in road to east; iron post stamped "1621 SA"	1,613.233
Weber's ranch, 6.25 miles southeast of, south side of slope, near summit of divide, east edge of road in limestone outcrop; bronze tablet stamped "1879 SA"	1,871.000

Ernest Hobort's ranch, 11 miles south of Fredericksburg, west over settlement road to Center Point road, thence north to Junction City road, thence east to Fredericksburg.

Hobort's ranch, 3.5 miles west of, at intersection of settlement road with Center Point road and Fredericksburg road, east side of road at gate; iron post stamped "1810 SA"	1,801.527
Fredericksburg, 11 miles by road and 7 miles direct southwest of, north slope of hill, east side of road, in limestone outcrop; aluminum tablet stamped "1746 SA"	1,738.158
Fredericksburg, 7.5 miles by road and 4 miles direct southwest of, 600 feet southwest of milestone 4, at narrow lane running west, west side of road; iron post stamped "1661 SA"	1,653.030
Fredericksburg, 3.5 miles west of, 60 feet east of intersection of settlement road with Junction City road, south side of Junction City road, in front of house; iron post stamped "1816 SA"	1,808.071

Point 2 miles west of Fredericksburg north along Lane and Fort Mason road to Crab Apple road and east to Enchanted Rock

Fredericksburg, 3.25 miles west of, southwest side of hill, south side of road, by wire fence; iron post stamped "1899 SA"	1,891.147
Fredericksburg, 7 miles northwest of, 100 feet southeast of Barrons Creek, 45 feet southeast of milestone 7, northeast side of road, by fence; iron post stamped "1954 SA"	1,946.208
Fredericksburg, 10 miles northwest of, 300 feet north of milestone 10, 4 feet north of 14-inch post-oak tree, east side of road; iron post stamped "2077 SA"	2,068.627
Fredericksburg, 13 miles northwest of, 55 feet north of milestone 13, east side of road, in mound of stone; iron post stamped "2077 SA"	2,069.423
Fredericksburg, 15.5 miles north of, junction of north-south with east-west road, northeast side; iron post stamped "1845 SA"	1,837.116
Fredericksburg, 17.75 miles north of, 200 feet east of W. C. Schneider's house and 10 feet north of road, in blue limestone outcrop; aluminum tablet stamped "1857 SA"	1,849.575
Fredericksburg, 16 miles north of, west side of drain, 100 feet east of stone marked "F B 16 M," 20 feet northeast of gate, in granite outcrop; aluminum tablet stamped "1724 SA"	1,716.236
H. Keese's ranch, 3 miles east of, in top of gray granite outcrop on north side of road; aluminum tablet stamped "1691 SA"	1,682.590
Enchanted Rock, 0.25 mile south of, 500 feet southeast of corrals at Moss's old ranch, 30 feet north of road, in top of pink granite bowlder; aluminum tablet stamped "1414 SA"	1,410.811

P. Scuch's ranch, 9 miles northwest of Fredericksburg, east over Settlement Road to Gobe's ranch, 6.5 miles northeast of Fredericksburg.

Peter Metzger's house, 400 feet northeast of, 15 feet south of gate, by wire fence; iron post stamped "2122 SA"	2,114.044

	Feet.
Fredericksburg, 8.5 miles north of, 100 feet north of dim road running west, on west side of Fredericksburg and Crab Apple road; iron post stamped "2096 SA"	2,083.199

Southwest along Fredericksburg and Burnet public road.

Blowout, 4.75 miles northeast of, 7 feet southwest of gate, 800 feet southwest of White Creek, on northwest side of road; iron post stamped "1075 SA"	1,066.699
Blowout, 1.75 miles northeast of, 2 feet southwest of gate, 500 feet southwest of Comanche Creek, on northwest side of road; iron post stamped "1240 SA"	1,231.906
Blowout, 1 mile southwest of, 11 feet east of stone wall on west side of road, in top of granite outcrop, 80 feet southwest of gate; bronze tablet stamped "1403 SA"	1,394.555
Blowout, 3.75 miles southwest of, at forks of road, 3 feet south of mail-box post; iron post stamped "1544 SA"	1,535.742
Willow City, 3.75 miles northeast of, 12 feet northeast of dead post-oak tree utilized as fence corner post, north side of road; iron post stamped "1630 SA"	1,621.870
Willow City, 8 feet west of northeast corner of Rick's cotton-gin yard, on south side of road; iron post stamped "1680"	1,671.661

GEORGETOWN QUADRANGLE.

McNeil to Bertram along Houston & Texas Central R. R., western division.

Cedar Park, 0.5 mile east of, west side of Round Rock and Buttercup public road crossing, 26 feet north of track; iron post stamped "893 SA"	885.281
Cedar Park, in front of post office; top of rail	911.2
Cedar Park, 1.25 miles northwest of, northwest side of Georgetown and Travis county line public road, 46 feet southwest of track, at right of way fence corner; iron post stamped "968 SA"	960.224
Leander, 1.66 miles southeast of, 45 feet southwest of track; iron post stamped "993 SA"	985.092
Leander, 650 feet south of station, south side of public road, 46 feet west of track; iron post stamped "983 SA"	975.078
Leander, in front of station; top of rail	972.4
Liberty Hill, 3 miles southeast of, north side of settlement road, 27 feet east of track; iron post stamped "968 SA"	960.064
Liberty Hill, in front of station; top of rail	1,030.1
Liberty Hill, 80 feet northwest of northwest corner of station, 50 feet northeast of main track on northwest side of Liberty Hill and Round Rock public road; iron post stamped "1040 SA"	1,032.198
Liberty Hill, 2.25 miles northwest of, south side of settlement road, 28 feet east of track; iron post stamped "1098 SA"	1,090.156

GIDDINGS QUADRANGLE.

Giddings, west along Houston & Texas Central R. R.

Giddings, Lee County courthouse, northeast corner of; bronze tablet stamped "520 SA"	512.424
Giddings, 2 miles west of, half way between mileposts 57 and 58, top of rock coping over southeast end of 18-inch drainpipe culvert 132; copper bolt stamped "487 SA"	478.978

	Feet.
Giddings, 3.75 miles west of, 15 feet north of main road, 50 feet west of road crossing small branch, west of Houston & Texas Central R. R.; iron post stamped "461 SA"	452.745

Giddings to Winchester along San Antonio & Aransas Pass Ry.

Giddings, 2.75 miles south of, in lane on west side of Giddings and Winchester public road, 35 feet south of south bank of Rabbs Creek and 50 feet west of center of track; iron post stamped "404 SA"	396.450
Serbin, 50 feet southeast of passenger station, 12 feet east of center of main track, 12 feet north of wagon road; iron post stamped "482 SA"	474.512
Serbin, 2.75 miles south of, northwest corner of right of way fence, 70 feet northwest of Giddings-Winchester public road crossing; iron post stamped "448 SA"	440.548
Winchester, 1.75 miles north of, northwest corner of right of way fence, 42 feet northwest of Giddings-Winchester public road crossing, 33 feet west of center of track; iron post stamped "400 SA"	392.534

Giddings to Lexington along San Antonio & Aransas Pass Ry.

Giddings, 1.75 miles north of, southwest corner of right of way fence, 55 feet southwest of crossing of Giddings-Lexington public road, between third and fourth telegraph poles south of milepost 187; iron post stamped "435 SA"	426.658
Giddings, 3.75 miles north of, 45 feet southwest of crossing of Giddings-Caldwell public road, 3 feet north of fence; iron post stamped "427 SA"	418.727
Lincoln, 70 feet northeast of passenger station, 22 feet east of main track; iron post stamped "367 SA"	358.662
Lincoln, in front of station; center of track	357.4
Lincoln, 1.5 miles north of, 65 feet southeast of Lincoln-Fedor public road crossing, 45 feet east of track, 3 feet northwest of the southeast corner of right of way fence; iron post stamped "381 SA"	372.643
Lincoln, 5.5 miles north of, 50 feet southeast of Giddings-Lexington public road, 850 feet north of Middle Yegua Creek; iron post stamped "348 SA"	339.627

SABINAL QUADRANGLE.

Hondo to Sabinal along Galveston, Harrisburg & San Antonio Ry.

Hondo River bridge, north end of east rock pier, in coping; copper bolt stamped "U.S.G.S. 832 B.M."	824.287
Hondo, in front of station; center of track	889.2
Hondo, Medina County courthouse, southwest corner of portico, in rock pedestal between two iron pillars; bronze tablet stamped "901"	893.293
Mile board 264, 10 feet east of; iron post stamped "904"	895.893
D'Hanis, in front of station; center of track	880.5
Seco River bridge, 11 telegraph poles east of mile board 269, in top of North end of east rock pier, copper bolt stamped "U.S.G.S. 889 B.M."	881.071
Seco, in front of signboard; top of tie	1,065.9

	Feet.
Mile board 274, 75 feet east of; iron post stamped "1006"	998.159
Sabinal, 0.25 mile east of station, 35 feet east of milepost 280, in solid rock; iron post stamped "957"	949.180
Sabinal, in front of station; top of tie	955.6

Sabinal and Utopia county road.

Sabinal, 4.5 miles northeast of, forks of Sabinal-Utopia county road and Bandera-Sabinal county road, 800 feet northeast of two-story stone house owned by Bascom Lyles, in forks of road; iron post stamped "1022"	1,014.286

Sabinal and Bandera (abandoned) county road.

Sabinal, 10 miles northeast of, 45 feet west of lone live-oak tree 15 inches in diameter, 30 feet east of road; iron post stamped "1102"	1,094.223

Sabinal south via Sabinal and Friotown road to Woodward's ranch, on Frio River.

Sabinal, 3.4 miles south of, intersection of Sabinal-Batesville and Sabinal-Friotown roads; iron post stamped "894 SA"	886.097
Sabinal, 6 miles south of, 20 feet west of road, and 50 feet north of the northeast corner of old stone house; iron post stamped "844 SA"	836.174
Sabinal, 10 miles south of, intersection of Sabinal-Friotown road with ranch road, 1 mile north of Sabinal Creek crossing; iron post stamped "799 SA"	791.190
Sabinal, 12 miles south of, intersection of Sabinal-Friotown and Friotown-Uvalde public roads; iron post stamped "768 SA"	760.145
Sabinal, 15.4 miles south of, intersection of Friotown public road with road which crosses Blanco Creek and Frio River just above the mouth of Sabinal Creek; iron post stamped "723 SA"	715.233
Woodward's ranch, 6 miles north of, 200 feet south of slough and 15 feet west of road, near plain cattle trail; iron post stamped "706 SA"	698.190
Woodward's ranch, 2 miles northwest of, at forks of road near gate, right-hand road very dim; iron post stamped "692 SA"	684.205
Friotown, 3.1 miles north of, east side of road at a point where road turns left to avoid mudhole; iron post stamped "653 SA"	645.130
Friotown, in foundation wall, east side of north entrance to abandoned courthouse building now used as store and post office; copper bolt stamped "632 SA"	624.566

Friotown to Moore, on International & Great Northern R. R., via Henson ranch.

Friotown, 3.8 miles east of, 125 feet north of gate on bank of Frio River, 15 feet south of road; iron post stamped "620 SA"	612.208
Friotown, 7.1 miles east of, 25 feet north of four hackberry trees and 15 feet south of road; iron post stamped "591 SA"	583.185
Friotown, 10.25 miles east of, 2 miles west of Hondo River, 3 feet south of fence at roadside; iron post stamped "594 SA"	586.199
Friotown, 13.6 miles east of, at forks of Friotown-Moore and Friotown-Pearsall Roads, 300 feet southeast of Henson ranch house; iron post stamped "615 SA"	607.198
Henson ranch, 3.25 miles east of, intersection of Pearsall-Hondo and Friotown-Moore Roads; iron post stamped "696 SA"	688.212

Tehuacana via settlement road to Moore station.

	Feet.
Moore, 4.3 miles west of, intersection of Friotown and Moore Road, via Henson ranch and Tehuacana road; iron post stamped "710 SA"	702.259
Moore, in front of station, 25 feet south of main track; iron post stamped "660 SA"	652.206

Pearsall to Hondo along public road.

Hondo River iron bridge, 0.75 mile west of, forks of Tehuacana and Moore Road and Pearsall and Hondo public road; iron post stamped "626 SA"	618.234
Hondo River bridge, 2.3 miles northwest of, intersection of Pearsall-Hondo public road with road to Friotown, near schoolhouse; iron post stamped "630 SA"	622.159
Hondo, iron bridge, 6.25 miles northwest of, 25 feet north of Newton's gate, where old Friotown-Castroville road enters Newton's pasture, 3 feet from fence in lane, west side of road; iron post stamped "656 SA"	648.009
Hondo, 9.8 miles south of, angle of fence, east side of road, 500 feet south of East Fork of Tehuacana Creek, about 0.75 mile northeast of Buck Hill; iron post stamped "761 SA"	752.829
Hondo, 6.75 miles south of, 20 feet south of Live Oak Slough, 40 feet south from three large live oak trees, 8 feet from east fence; iron post stamped "782 SA"	773.732
Hondo, 3.25 miles south of, corner of fence at intersection of roads; iron post stamped "840 SA"	831.856

Dunlay, on Galveston, Harrisburg & San Antonio Ry., south to Briar Branch settlement, along old Friotown and Castroville road and third-class road.

Dunlay, 8.25 miles south of, intersection of Quihe-Devine road with old Friotown-Castroville road; iron post stamped "816 SA"	808.110
Dunlay, 11 miles south of, 3.9 miles east of Hondo River crossing, intersection of roads, 125 feet north of gate; iron post stamped "775 SA"	767.215
Hondo River, west bank of, 10 feet east of road at the Readus crossing and 20 feet northeast of gate; iron post stamped "704 SA"	696.149
Seco Creek crossing, 2.1 miles northeast of, forks of road 75 feet northeast of an old fence, with gatepost but no gate; iron post stamped "697 SA"	688.836

Point 0.25 mile west of the Seco Creek crossing northwest 3 miles along settlement road branching off the old Friotown and Castroville road.

Seco Creek crossing, 3 miles west of, at forks of settlement road and Friotown-Hondo county road; iron post stamped "678 SA"	669.690

Hondo City and Friotown public road southwest to Blackaller's ranch road, thence to Blackaller's residence.

Blackaller's residence, 4 miles northeast of, at side of road where present road leaves old road on account of wash, returning a short distance below; iron post stamped "666 SA"	658.209

Blackaller's residence to Charles Woodward's residence, west of Frio River, via branch road.

Charles Woodward's ranch, 4.9 miles southwest of, 4.75 miles west of Friotown, intersection of ranch road and Friotown and Uvalde public road; iron post stamped "673 SA"	665.517

Friotown and Uvalde public road southeast to Friotown.

	Feet.
Blackaller's ranch, 6 miles north of, 35 feet south of road, 80 feet south of Woodward's windmill, 200 feet east of mesquite pole fence running north and south in Woodward's pasture; iron post stamped "790 SA"	782.189
Blackaller's ranch, 9 miles north of, in front of V. Johnson's residence, on road leading from Friotown and Hondo road near John Allen's place to Sabinal, 2,000 feet south of Squirrel Creek; iron post stamped "815 SA"	807.223
V. Johnson's, 3.5 miles north of, 9.75 miles southwest of D'Hanis, in corner of fence 10 feet east of gate; iron post stamped "925 SA"	917.186
D'Hanis, 6.5 miles southwest of, at forks of road 50 feet south of gate, fence running east and west; iron post stamped "966 SA"	958.227

Ranch road to John Fohn's ranch southeast to Old D'Hanis.

Mile board 266, 4.5 miles southeast of, near gate 10 feet west of road, 1.5 feet north of fence; iron post stamped "981 SA"	973.062
Mile board 266, 9.75 miles southeast of, 8.75 miles southwest of Hondo, intersection of roads, east of Fohn's road and south of Major Moore's ranch road to Hindo City (Fohn road crosses the Hondo road and third-class Friotown road, about 0.25 mile southeast of bench mark); iron post stamped "848 SA"	840.231

Hondo and Friotown third-class road southwest to Capt. J. D. Smith's ranch.

Seco Creek crossing, 2.4 miles east of, at Capt. J. D. Smith's residence, 50 feet north of road, 50 feet from southeast corner of house, 65 feet northwest of 20-inch mesquite tree; iron post stamped "777 SA"	769.703
Seco Creek crossing, 2.5 miles west of, 25 feet south of road, 25 feet west of branch, 0.5 mile northwest of High Hill Point; iron post stamped "789 SA"	781.478

HALSTEAD QUADRANGLE.

At Moravia.

Moravia, 0.25 mile west of, near fence line at intersection of Witting-Moravia and Hallettsville-Flatonia public roads, 8.25 miles northwest of Witting; iron post stamped "405 SA"	397.030

LLANO QUADRANGLE.

Graphite to Llano along Houston & Texas Central R. R.

Graphite station, in front of; top of rail	978.6
Graphite, 1.25 miles northwest of, on north side of Lone Grove public road, 19 feet east of track; iron post stamped "1015 SA"	1,006.475
Graphite, 3.75 miles northwest of, on northwest side of a private road, 500 feet southeast of trestle 91 A, 22 feet southwest of track; iron post stamped "967 SA"	958.651
Llano, 5.75 miles northeast of, 50 feet northeast of gate at entrance to Bessemer station grounds, 150 feet north of track; iron post stamped "988 SA"	979.621
Llano, 2.25 miles southeast of, 9 feet east of private road gate, 45 feet north of track; iron post stamped "1027 SA"	1,018.503

	Feet.
Llano, in front of station; top of rail	1,020.9
Llano, in front of small park at east end of freight station, 32 feet south of main track; iron post stamped "1029 SA"	1,020.743
Llano, county courthouse, south side of entrance on east front of, in face of pedestal to pillar; bronze tablet stamped "1050 SA"	1,041.632

Llano south via Oxford along public road to Fredericksburg.

Llano, 2.75 miles south of, on west side of road, 125 feet south of Oatman Creek, 45 feet south of northeast corner of a cultivated field; iron post stamped "1075 SA"	1,066.715
Llano, 6 miles south of, 41 feet west of east fence line of road, 22 feet west of wagon tracks in clump of scrub live oaks on summit of hill; iron post stamped "1244 SA"	1,235.864
Oxford, 1.75 miles north of, 90 feet north of 26-inch dead oak tree on west side of road near summit of hill; iron post stamped "1430 SA"	1,421.890
Oxford, 15 feet south of post office, on west side of road; iron post stamped "1333 SA"	1,324.765
Oxford, 2.25 miles south of, 14 feet south of gate on east side of road, at junction with settlement road running east to Click; iron post stamped "1221 SA"	1,212.873
Oxford, 4.7 miles south of, 5 feet south of 13-inch post-oak tree utilized as a gatepost, on west side of road, at junction with road running west to Enchanted Rock; iron post stamped "1261 SA"	1,252.869

Point 4 miles west of Smith's ranch to point 2.25 miles south of Oxford via Click.

Click, 4 miles southeast of, 40 feet south of telephone pole, southwest side of road on summit of hill; iron post stamped "1117 SA"	1,108.881
Click, 2 miles southeast of, south side of road by fence corner, at junction with settlement road running northeast, 0.75 mile west of Sandy Creek; iron post stamped "1003 SA"	994.823
Click, 0.12 mile east of post office, 75 feet north of northwest corner of schoolhouse at forks of roads; iron post stamped "1051 SA"	1,042.782
Click Gap, southeast side of road, in top of gray sandstone ledge, 13 feet north of twin live oak tree, 40 feet southwest of summit; bronze tablet stamped "1393 SA"	1,384.813
Click Gap, 2.75 miles southwest of, at forks of settlement road running east through Sandy Gap, 500 feet southwest of Moore's farmhouse; iron post stamped "1099 SA"	1,090.680

Point near Oxford northwest along settlement road.

Oxford, 4 miles southeast of, 0.25 mile east of Hondo Creek, south side of road, 12 feet north of 48-inch live oak tree, 35 feet southeast of 45-inch post oak tree, on summit of hill; iron post stamped "1194 SA"	1,185.696

Click to point 2.2 miles south of Llano via Round Mountain and Llano upper road.

Click, 3 miles north of, 4 feet north of east gatepost at forks of roads; iron post stamped "1184 SA"	1,176.094
Click, 6.25 miles north of, in top of conglomerate rock, 50 feet southeast of fence angle west of wagon tracks; bronze tablet stamped "1149 SA"	1,141.084

	Feet.
Click, 9 miles north of, in top of limestone outcrop, south side of road, 7 feet south of stone wall corner; bronze tablet stamped "1313 SA"	1,304.644
Riley Mountain, 8.75 miles southeast of Llano, 30 feet east of 6-inch scrub oak, 15 feet south of road, on triangular limestone 50 by 36 by 50 inches; chiseled cross on rock marked "U. S. G. S. B. M." 1568	1,559.62
Llano, 7 miles southeast of, on southwest side of road by twin mesquite tree, at junction with a settlement road running south to Middlebrook's ranch; iron post stamped "1252 SA"	1,243.740
Llano, 3.75 miles southeast of, 12 feet north of gate on east side of wire fence; iron post stamped "1095 SA"	1,087.050

Llano north along public road to Cherokee.

Llano, 3 miles north of, 4 feet south of wire-fence corner on east side of road, at junction with settlement road running east; iron post stamped "1112 SA"	1,104.031
Babyhead, 3.25 miles south of, in pink granite outcrop 15 feet west of east fence line, opposite to small corral; aluminum tablet stamped "1253 SA"	1,244.810
Babyhead, 250 feet southeast of post office, in top of sandstone outcrop, west side of road in front of small corral; aluminum tablet stamped "1348 SA"	1,339.614
Babyhead, 3 miles north of, in top of flat granite bowlder on east fence line of road, 600 feet southeast of bend; aluminum tablet stamped "1440 SA"	1,431.760
Cherokee, 2.5 miles south of, 6 feet south of fence corner, at southeast corner of crossroads; iron post stamped "1515 SA"	1,507.012
Cherokee, West Texas Normal and Business College, in sandstone trimming at northwest corner of west wing of building, 6 inches above water table; aluminum tablet stamped "1530 SA"	1,522.058

Cherokee east along Mason and Lampasas road.

Cherokee, 3.5 miles east of, on west bank of Salt Branch, 10 feet south of road, 15 feet northwest of 6-inch mesquite tree; iron post stamped "1412 SA"	1,404.041
Cherokee, 6.75 miles east of, 5 feet southeast of road at bend, in top of limestone outcrop; aluminum tablet stamped "1400 SA"	1,391.787
Cherokee, 9.33 miles east of, at junction of Mason and Lampasas Road with San Saba and Bluffton Road; iron post stamped "1317 SA"	1,308.978

South along San Saba and Bluffton road to Boyt's ranch.

Boyt's ranch, at southwest corner of fence inclosing yard at residence of T. W. Boyt, on east side of road; iron post stamped "1461 SA"	1,453.366

South along settlement road via Tow's and Kuykendall's ranches to Lone Grove and Houston & Texas Central Ry.

Boyt's ranch, 3 miles south of, on top of embedded limestone bowlder 10 feet west of road at highest point of open prairie; bronze tablet stamped "1501 SA"	1,493.039

	Feet.
Tow's ranch, 1.5 miles south of, in top of embedded limestone bowlder 15 feet northwest of gate, southwest side of road; bronze tablet stamped "1422 SA"	1,414.253
Tow's ranch, 3 miles south of, east side of road, on summit of hill, divide between Falls and Miller Creeks; iron post stamped "1559 SA"	1,550.810
Lone Grove, 3.25 miles northeast of, 25 feet north of gate, west side of road at junction of Llano and Lampasas Road with settlement road to Kuykendall's ranch; iron post stamped "1141 SA"	1,132.772
Lone Grove, 150 feet west of post office, 5 feet south of fence in front of cotton gin and on northeast bank of Little Llano Creek; iron post stamped "999 SA"	990.911

Llano via Valleyspring to Field Creek along public roads.

Llano, 3 miles northwest of, northeast side of road near summit of slight incline in front of leaning live-oak tree, 27 feet southeast of telephone pole; iron post stamped "1131 SA"	1,122.892
Llano, 6 miles northwest of, 3 feet west of northwest fence corner, 250 feet north of milepost "To L 6" at bend in road from south to west; iron post stamped "1161 SA"	1,153.109
Valleyspring, 3.5 miles southeast of, 150 feet southeast of gate, on northeast side of road, 35 feet west of 30-inch post-oak tree bearing mile board "To L 9"; iron post stamped "1207 SA"	1,199.161
Valleyspring, 0.5 mile southeast of post office, in top of embedded granite bowlder on south side of summit of hill, 200 feet southwest of Methodist Episcopal Church; aluminum tablet stamped "1335 SA"	1,326.677
Valleyspring, 2.66 miles northwest of, north side of road at bend, 15 feet north of twin post-oak tree; iron post stamped "1450 SA"	1,441.657
Valleyspring, 5.66 miles north of, in top of limestone outcrop, northeast side of road, 120 feet northwest of mile-board "Llano 17 miles," opposite to R. Baumann's farm residence; aluminum tablet stamped "1485 SA"	1,476.903
Field Creek, 1.75 miles southeast of, at northwest corner of intersection with settlement road running northeast and southwest, at summit of a small hill; iron post stamped "1407 SA"	1,398.424
Field Creek, in northwest corner of McLeod, Appleton & Co.'s general store, 4 feet above ground; aluminum tablet stamped "1414 SA"	1,405.985

Field Creek north along settlement road via Wilson's ranch to Pontotoc and San Saba road.

Field Creek, 2.25 miles northeast of, at junction of Pontotoc and San Saba Road with settlement road, 0.25 mile north of W. R. Wilson's ranch; iron post stamped "1617 SA"	1,607.476

Northeast along Pontotoc and San Saba road.

Field Creek, 4 miles northeast of, 20 feet east of road, east side of 18-inch blackjack tree, 50 feet south of summit of hill, in top of embedded bowlder; aluminum tablet stamped "1784 SA"	1,775.701
Field Creek, 7 miles northeast of, at junction of Mason-Lampasas Road; iron post stamped "1752 SA"	1,743.961

Point 7 miles northeast of Field Creek east along Mason and Lampasas road to Cherokee.

	Feet.
Cherokee, 9 miles west of, in top of embedded limestone bowlder, southeast side of road, 25 feet east of gate, 12 feet southeast of 14-inch live-oak tree; bronze tablet stamped "1703 SA"	1,694.623
Cherokee, 5.33 miles west of, on east side of road, 6 feet southeast of gate on division fence line between lands of A. R. Kuykendalls and R. W. Gray; iron post stamped "1615 SA"	1,606.457
Cherokee, 2.5 miles west of, on south side of road, 5 feet south of gate on division-fence line between lands of R. W. Gray and George Gray; iron post stamped "1551 SA"	1,542.734

Cherokee to Valleyspring along public road.

Cherokee, 3.5 miles southwest of, north side of road by wire fence, 6 feet from gate; iron post stamped "1531 SA"	1,522.914
Valleyspring, 5.75 miles northeast of, in top of sandstone ledge 9 feet southwest of 10-inch elm tree, 35 feet northeast of Pecan Creek, east side of road; aluminum tablet, stamped "1412 SA"	1,403.930
Valleyspring, 2.33 miles northeast of, at junction with settlement road southeast; iron post stamped "1374 SA"	1,365.841

Valleyspring southwest along public road to Castell.

Valleyspring, 4.33 miles southwest of, at junction with settlement road running west, 75 feet southwest of small creek; iron post stamped "1274 SA"	1,265.938
Valleyspring, 7.25 miles southwest of, south side of road, 5 feet west of gate at end of lane; iron post stamped "1314 SA"	1,306.018
Valleyspring, 9.5 miles southwest of, 40 feet north of summit of road at Kings Mountain, in top of pink granite outcrop west of road; aluminum tablet stamped "1424 SA"	1,416.472
Castell, 7 miles north of, at southeast corner of intersection of Mason-Burnet and Castell-Pontotoc roads; iron post stamped "1326 SA"	1,317.968

Point 7 miles north of Castell south along Castell and Pontotoc road.

Castell, 3.5 miles north of, 3 feet east of gate on east side of road; iron post stamped "1272 SA"	1,263.852
Castell, 5 feet north of southwest fence corner at "Traveler's Home," 75 feet east of T. Buchholz's general store and post office; iron post stamped "1207 SA"	1,199.132

Castell to Llano eastward along Llano and Mason road.

Castell, 3.33 miles east of, 5 feet west of fence corner at junction with Loyal Valley road opposite 15-mile board ("15 miles to L V."); iron post stamped "1208 SA"	1,200.312
Castell, 6 miles east of, 12 feet east of 12-inch elm tree northwest side of road at point where lane runs north to river; iron post stamped "1154 SA"	1,146.167
Castell, 8.75 miles east of, 30 feet south of road on west bank of Hickory Creek; iron post stamped "1111 SA"	1,103.048
Llano, 6 miles west of, north side of road, east bank of Sixmile Creek, 40 feet northeast of granite post, marked "To Llano 6 miles;" iron post stamped "1085 SA"	1,077.291

	Feet.
Llano, 3 miles west of, northwest side of road at summit of hill 100 feet northeast of milestone "To Llano 3 miles"; iron post stamped "1083 SA"	1,075.523

Oxford to House Mountain along settlement roads via Bennett schoolhouse and Balcom's ranch.

Oxford, 3.5 miles west of, 10 feet south of road at summit of hill, in top of sandstone bowlder; bronze tablet stamped "1497 SA"	1,489.222
Oxford, 6 miles west of, 100 feet northwest of Bennett's schoolhouse, at fence corner, south side of road; iron post stamped "1403 SA"	1,394.957
Oxford, 9.5 miles west of, 60 feet northwest of gate, at junction of old Llano and Fredericksburg road, with a settlement road 0.75 mile northeast of Bull Head Creek, in top of granite outcrop; aluminum tablet stamped "1322 SA"	1,314.176
Balcom's ranch, 1.25 miles west of, 450 feet southwest of junction with settlement road running north and south, 2 feet above ground, northwest side of road, in top of pink granite outcrop; aluminum tablet stamped "1324 SA"	1,315.937
Balcom's ranch, 4 miles west of, 800 feet east of a small creek about 1 mile east of House Mountain, 15 feet west of where road passes dim road, southwest side of road, in top of pink granite outcrop; aluminum tablet stamped "1345 SA"	1,336.614

House Mountain to Enchanted Rock along settlement road via August Keese's ranch.

Hayne's ranch, 3.5 miles north of, at forks of road 0.33 mile northwest of Marshall Creek; iron post stamped "1369 SA"	1,360.758
Hayne's ranch, 300 feet south of Henry Hayne's residence, west side of road, in top of pink granite bowlder; aluminum tablet stamped "1425 SA"	1,416.917
Putman's ranch, 0.5 mile southeast of, northeast bank of Hickory Creek, 75 feet southwest of road, in red sandstone ledge; aluminum tablet stamped "1525 SA"	1,517.230
August Keese's ranch, 0.75 mile east of, 125 feet south of fence dividing lands of August Keese and H. Keese, in small open flat 250 feet east of settlement road running north and south, in top of pink granite outcrop; aluminum tablet stamped "1749 SA"	1,741.397

Enchanted Rock northeast along settlement road to Watch Mountain.

Watch Mountain, 1.25 miles south of, 25 feet north of road, on south bank of small branch, in top of gray granite outcrop; aluminum tablet stamped "1374 SA"	1,365.805

Watch Mountain east to Aaron Moss's ranch.

Watch Mountain, 2.2 miles east of, 0.5 mile west of Aaron Moss's ranch, 450 feet southwest of Sand Creek, 20 feet northwest of road, 3 feet southeast of post oak tree, in top of pink granite bowlder; aluminum tablet stamped "1270 SA"	1,262.064
Moss's ranch, 2.25 miles southeast of, 200 feet southeast of Crab Apple Creek, 10 feet west of 11-inch hickory tree, south side of road, in top of pink granite bowlder; aluminum tablet stamped "1188 SA"	1,179.642
Boyt's ranch, 1.33 miles southeast of, in quartz bowlder between two 20-inch live oak trees 30 feet south of road; bronze tablet stamped "1497 SA"	1,489.055

NEW BRAUNFELS QUADRANGLE.

San Marcos to San Antonio along the International & Great Northern Ry.

	Feet.
Yorks Creek railroad bridge, in top of west end of north rock pier near mile board 219; copper bolt stamped "U.S.G.S. 627 B.M."	621.629
Goodwin, 40 feet east of main track, 5 feet south of first telegraph pole north of station; iron post stamped "695 SA"	690.143
Goodwin, in front of station; center of track	690.7
New Braunfels, in front of station; center of track	637.1
Dry Comal Creek, railroad bridge, in top of north end of east rock pier; copper bolt stamped "U.S.G.S. 638 B.M."	633.26
Mile board 234, 75 feet north of trestle 507, 5 feet south of second telegraph pole south of mile board 234; iron post stamped "692"	686.98
Corbyn, in front of signboard; center of track	708.7
Mile board 240, southeast corner of right of way fence at private road crossing near second telegraph pole west of; iron post stamped "769"	764.0
Davenport station, in front of; center of track	797.6
Cibolo River railroad bridge, in southeast end of north rock pier; copper bolt stamped "U.S.G.S. 789 B.M."	783.700
Wetmore siding, 1.75 miles east of, 40 feet north of center of track, 25 feet east of road crossing, 1,000 feet north of church; iron post stamped "849"	844.0
Wetmore, in front of mail hook; center of track	816.4
Adams siding, 2 miles northeast of, 40 feet east of center of wagon road, 40 feet south of center of track, 2 feet from fence; iron post stamped "786"	780.176
Adams siding, in front of signboard; center of track	718.1
San Antonio, 3 miles north of station, 100 feet north of "city limits" signboard, in corner of right of way fence, near second telegraph pole south of milepost 258; iron post stamped "747"	742.19

San Antonio to Seguin along Galveston, Harrisburg & San Antonio Ry.

Converse, in front of station; center of track	712.5
Cibolo Creek, southwest end of west brick pier; copper bolt stamped "U.S.G.S. 725 B.M."	717.1
Cibolo, northwest corner of Charles Fromer's store, in vertical rock wall; bronze tablet stamped "712"	703.6
Marion, in front of station; center of track	643.9
Marion, north side of tracks, 5 feet north of first telegraph pole east of station; iron post stamped "651"	642.905
Guadalupe River Bridge, east end of west rock pier, near section house 81; bronze tablet stamped "552"	544.339

SAN ANTONIO SPECIAL QUADRANGLE AND THREE ADJOINING 15' QUADRANGLES ON SOUTH AND WEST.

Dunlay station to Converse along Galveston, Harrisburg & San Antonio Ry.

Dunlay, 60 feet east and 30 feet south of, southwest corner of station; iron post stamped "999"	990.575
Dunlay, 4 miles east of, 40 feet south of track, near corner of right-of-way fence, between mileposts 245 and 246; iron post stamped "858"	849.872

	Feet.
Noonan, opposite signboard; top of tie	768.4
Noonan, 0.25 mile east of, at Chicon Creek Bridge, in top of south end of east rock pier; copper bolt stamped "U.S.G.S. 757 B.M."	748.196
Lacoste, 2.25 miles west of, at crossing of Castroville and Devine road, midway between mileposts 237 and 238, 50 feet south of track, in southwest corner of right of way fence; iron post stamped "815"	806.725
Idlewild, in southeast corner of right of way fence, 1,200 feet west of water tank, 40 feet south of track; iron post stamped "692"	683.854
Idlewild, in front of signboard; center of track	681.4
Medina River Bridge, in north end of west pier (high-water channel); copper bolt stamped "U.S.G.S. 616 B.M."	608.279
Medina River, 2 miles east of, midway between mileposts 224 and 225, at crossing of San Antonio-Frio road, in corner of right-of-way fence, 50 feet north of track; iron post stamped "627"	618.858
Mileposts 220 and 221, midway between, at southwest corner of section house, 40 feet north of track; iron post stamped "636"	627.944
Withers, sidetrack, in front of signboard; top of tie	631.6
San Antonio, 4 miles west of, midway between mileposts 216 and 217, near corner of right of way fence at San Antonio and Frio road crossing, 40 feet south of track; iron post stamped "681"	672.992

At San Antonio.

San Antonio, in front of Galveston, Harrisburg & San Antonio Ry. passenger station; top of rail	675.1
San Antonio, post-office building, corner of Houston Street and Avenue D, in southwest corner; bronze tablet stamped "669"	661.180
San Antonio, Bexar County courthouse, east side, around first cellar window south of north entrance, top of flat granite coping; bronze tablet stamped "655.7"	647.794
San Antonio city hall, east entrance, top of large stone north side of steps; bronze tablet stamped "661.1"	653.212
Kerby, opposite signboard; center of track	707.0
Mile board 201, sixth telegraph pole east of, 1.5 feet from wire fence; iron post stamped "735"	727.688

San Antonio north along International & Great Northern Ry.

San Antonio, 10 miles north of, trestle 542, 100 feet north and 50 feet east of track, half way between mileposts 244 and 245, in large rock; copper bolt stamped "U.S.G.S. 776 B.M."	767.197

San Antonio along upper Castroville road to point 2.8 miles west of city limits, thence south partly across country 3.4 miles to Castroville road, thence west and north along Castroville and Canyon roads to Galveston, Harrisburg & San Antonio R. R. milepost 228.

San Antonio, 1.1 miles directly west of city limits, 1,300 feet south of St. Louis College, north side of upper Castroville road, 10 feet east of avenue; iron post stamped "722 SA"	713.964
San Antonio, 2.8 miles west of city limits, 1.8 miles west of avenue to St. Louis College, 0.2 mile east of Salsamora Creek, south side of road, 3 feet east of gate entrance to pasture; iron post stamped "746 SA"	737.881

	Feet.
San Antonio, 3.9 miles west of city limits, on lower Castroville road, south side of road, by wire fence, 140 feet west of bridge over Leon Creek; iron post stamped "689 SA"	680.424
San Antonio, 6.8 miles west of city limits, on lower Castroville road, at top of hill, south side of road, 0.9 mile east of Medio Creek, 2 feet east of milepost 10, by wire fence; iron post stamped "813 SA"	805.084
San Antonio, 10.5 miles west of city limits, on Castroville road, at forks with Canyon road south, 1.9 miles north of Medina River, at fence corner; iron post stamped "762 SA"	753.753

Castroville road north along Canyon road to Culebra Creek, thence southeast along Culebra Creek and upper Castroville roads to Salsamora Creek.

San Antonio, 11 miles west of city limits, on upper Castroville road, at intersection of Canyon road, on west side of Caracal Creek, at southeast fence corner; iron post stamped "812 SA"	803.681
San Antonio, 10.4 miles west of city limits, south side of Culebra Creek road, north side of Culebra Creek, 4.5 miles northwest of Leo Creek crossing of upper Castroville road, by wire fence; iron post stamped "857 SA"	849.117
San Antonio, 7.3 miles west of city limits, west side of Culebra road, 0.3 mile south of Culebra Creek, and 1.5 miles northwest of Leon Creek crossing of upper Castroville road, at angle in road, by wire fence; iron post stamped "815 SA"	807.184

San Antonio, near milepost 205, Galveston, Harrisburg & San Antonio Ry., east over Binz-Engleman road, thence southeast over Georgetown road, west on Hedwick road, and south via Sayers to Sulphur Springs road, thence west to San Antonio.

San Antonio, 2 miles east of city limits, south of Binz-Engleman public road and 60 feet south of Galveston, Harrisburg & San Antonio Ry. track, near crossing; iron post stamped "682 SA"	674.004
San Antonio, 6 miles east of city limits, 2.2 miles east of Rosillo Creek, summit of ridge at angle of road; iron post stamped "707 SA"	699.131
Converse, 4 miles southeast of, west side of Binz-Engleman road, 30 feet south of Greytown road, at intersection; iron post stamped "670 SA"	662.203
Martinez, 5.5 miles directly east of, on north side of St. Hedwig road by wire fence at intersection with road leading north; iron post stamped "653 SA"	645.082
Sayers, 4 miles southwest by road, and 2.8 miles direct, 8 miles east of city limits of San Antonio, on New Sulphur Springs road at crossing of Arroyo Hondo road, by southeast fence corner; iron post stamped "593 SA"	585.204
San Antonio, 3.6 miles southeast of city limits, 700 feet west of farmhouse, on south side of road, at angle in road; iron post stamped "616 SA"	608.276
San Antonio, 0.2 mile east of east city limits, south side of Sulphur Springs road, 6 feet northeast of W. R. Wurzbach's store; iron post stamped "714 SA"	706.505

Point southeast of Sayers southeast along Arroyo Hondo road to point 4 miles north of Elmendorf, thence west along various roads via Hillman to Leon.

	Feet.
Elmendorf, 4.2 miles north of, in forks of Arroyo Hondo and Upson roads, at corner of wire fence; iron post stamped "507 SA"	499.166
Hellemans, 5.6 miles direct or 8 miles by road east of, 6 miles southeast of corner of San Antonio city boundary, north side of road, by wire fence, 11 feet east of gate; iron post stamped "571 SA"	563.208
Hellemans, 4 miles southeast of, at intersection of W. W. White's road with Goliad-San Antonio road, 0.5 mile south of mouth of Rosillo Creek joining Salado Creek, southwest side of road by wire fence, 3 feet east of telephone pole; iron post stamped "570 SA"	562.211
Hellemans (Berg's station), on San Antonio & Aransas Pass Ry., 600 feet east of, northwest corner of San Juan and Pressa road; iron post stamped "560 SA"	552.279
Hellemans, 4 miles southwest of, at crossing of Mission and San Antonio-Pleasanton roads, at northeast fence corner; iron post stamped "SA 618"	610.325
Leon, 2.7 miles southeast of, 4.5 miles south of San Antonio city limits, north side of Mission road, 6 feet east of Apple White-San Antonio roads, at northeast fence corner; iron post stamped "617 SA"	609.262

Intersection of W. W. White road with Goliad-San Antonio road southeast via Calaveras and Fairview to Verdi, thence north via Loire and Losoyo to point 7 miles north of Losoyo.[1]

Elmendorf, 2.2 miles northwest of, south side of road, 4 feet north of gate; iron post stamped "529 SA"	521.342
Sampasco switch, at road crossing, 15 feet south of track, 20 feet north of public road; iron post stamped "488 SA"	480.207
Calaveras, in front of station; center of track	411.7
Calaveras, 0.75 mile south of, summit of small ridge, east side of road by wire fence; iron post stamped "428 SA"	420.437
Calaveras, 3.75 miles south of, summit of ridge, east side of road, by wire fence; iron post stamped "537 SA"	529.373
Fairview, 1 mile north of, 1,000 feet north of road forks, west side of road by wire fence; iron post stamped "569 SA"	561.159
Fairview, 3.5 miles southwest of, north side of road, 4 feet north of gate by wire fence; iron post stamped "519 SA"	511.648
Verdi, 6 feet northeast of post office, by wire fence; iron post stamped "455 SA"	447.455
Loire, southeast corner of post office; iron post stamped "518 SA"	510.618
Loire, 3.5 miles north of, east side of road by wire fence, 2 feet north of gate in front of Washington Williams's house; iron post, stamped "598 SA"	590.714
Losoyo, 4 miles south of, east side of road, by wire fence, at offset in lane; iron post stamped "575 SA"	567.820
Losoyo, 35 feet north of post office, east side of road by fence; iron post stamped "514 SA"	506.741

Earle south to Childress store.

Earle, 0.8 mile north of post office, east side of road by wire fence, 600 feet north of gates; iron post stamped "522 SA"	514.250
Earle, 2 miles north of, west side of road by wire fence, opposite milepost "SA 14"	556.117

[1] The error distributed in this circuit exceeds the allowable limit.

	Feet.
Earle, 4.5 miles south of, west side of road at fence corner, midway between mileposts 16 and 17; iron post stamped "593 SA"	585.174
Earle, 7 miles south of, west side of road by wire fence, opposite milepost "SA 19 N;" iron post stamped "594 SA"	586.310
Earle, 10.5 miles south of, west side of road by wire fence, 100 feet west of settlement road running northeast through gate; iron post stamped "526 SA"	518.196
Childress store, northeast fence corner, 40 feet west of store; iron post stamped "507 SA"	499.199
Childress store west along settlement roads via John Cavender ranch north to Gates Valley Church.	
Childress store, 4.2 miles west of, 4 feet east of gate, west of entrance to John Cavender's pasture, east side of road; iron post stamped "501 SA"	493.032
Gates Valley Church, 2,000 feet north of, southeast side of road at forks, 200 feet south of H. Meadow's house, at rail fence; iron post stamped "525 SA"	517.099
Gates Valley Church north along Gates Valley and Amphion roads to Mission road.	
Gates Valley Church, 2.8 miles north of, at gate, in forks of road by wire fence; iron post stamped "585 SA"	577.254
San Antonio, 21.5 miles south of, west side of road by wire fence, 1,400 feet north of sand ridge east and west, 900 feet south of gate; iron post stamped "657 SA"	649.404
San Antonio, 18.5 miles south of, 900 feet north of settlement road running southeast, west side of road, 4 feet north of 24-inch blazed blackjack tree; iron post stamped "751 SA"	743.221
San Antonio, 15.8 miles south of, summit of ridge, 1,800 feet north of church, east side of road by wire fence; iron post stamped "631 SA"	623.479
Divide between Medina and Leon Creek, west side of road by wire fence; iron post stamped "611 SA"	603.123
Medina River Bridge, Galveston, Harrisburg & San Antonio Ry., southeast along highway via Bexar and Rossville to Gates Valley Church.	
Medina River Bridge, north end of west pier; copper bolt	608.218
Macedonia, 3.8 miles south of, 2.5 miles west of Vonormy, 100 feet north of International & Great Northern R. R. track at road crossing, north side of Bexar and San Antonio road by wire fence; iron post stamped "653 SA"	645.072
Bexar, 1 mile north of, northeast of road crossing, by 18-inch post oak tree utilized as fence corner post; iron post stamped "634 SA"	626.239
Bexar, 1 mile south of, 275 feet north of lane running west, 8 feet west of 30-inch post oak, east side of road by wire fence; iron post stamped "682 SA"	674.203
Summerset, 2 miles south of, 6 feet north of 14-inch hickory, east side of road by wire fence; iron post stamped "745 SA"	737.162
Rossville, 3.2 miles north of, east side of road at southeast fence corner of cultivated field; iron post stamped "651 S.A."	643.101
Rossville, southwest corner of post office, east side of road; iron post stamped "557 SA"	549.211
Rossville, 3 miles east of, fence corners at dim road east and west across Benton-Pleasanton road; iron post stamped "563 SA"	555.143

SAN MARCOS QUADRANGLE.

San Marcos along road via Zorn and Geronimo to Seguin.

	Feet.
San Marcos, river bridge 0.5 mile east of International & Great Northern R. R. passenger station, east end of north rock pier; copper bolt stamped "585"	577.732
San Marcos, 2 miles south of, in forks of road, southwest corner, near sign post "Staples 10 miles; Seguin 25 miles;" iron post stamped "626"	625.540
San Marcos, 5 miles south of, 150 feet northeast of W. E. Gray's store, 5 feet south of telephone pole west of road; iron post stamped "626"	625.769
Zorn, 2 miles north of, west of road, 50 feet north of gate, 200 feet east of house, mail box 25; iron post stamped "628"	628.336
Zorn, 50 feet northeast of store, between hitching rail and fence, 100 feet southwest of road crossing; iron post stamped "529"	529.848
Zorn, 4 miles south of, 300 feet east of schoolhouse, at northwest corner of road crossing, mail box 20; iron post stamped "614"	614.321
Geronimo, in front of store between hitching post and gallery; iron post stamped "584"	583.415
Geronimo, 2.8 miles south of, at intersection of lane from east, 10 feet south of mail box 4, marked H. A. Glaeser, 250 feet northwest of house; iron post stamped "584"	583.422
Seguin, 1.5 miles north of, Coast and Geodetic Survey triangulation station Mott, 25 feet west of road, in concrete monument; nail marked "U. S. 1903 C. & G. S."	581.144
Seguin, 25 feet north of main track, 1.5 feet east of fence around small park in front of station; iron post stamped "560 S A"	552.115

Seguin by road and San Antonio & Aransas Pass Ry. via Belmont to Luling.

Seguin, 3.4 miles east of, 250 feet east of Geronimo Creek, 10 feet west of road at road crossing; iron post stamped "474"	474.204
Junior, 1.5 miles east of, 50 feet southeast of Aug. Maurer's mail box, 15, in forks of road; iron post stamped "525"	525.45
Junior, 3.8 miles east of, at Hy. Bering's mail box, 28, 50 feet east of, at northwest corner of crossroads; iron post stamped "512"	512.081
Junior, 8.1 miles east of, 50 feet east of Henry Denman's store, near gate on wire fence; iron post stamped "448"	448.510
Belmont, 3 miles west of, 150 feet south of L. G. Denman's house (occupied by W. A. Huggins), 20 feet west of gate south of road; iron post stamped "427"	426.551
Belmont, G. A. Sather's store, southeast corner, in wall 3 feet above ground and 1.5 feet from corner; bronze tablet, set vertically, stamped "393"	392.664
Belmont, 2.8 miles north of, at forks of roads, 10 feet north of mail box 10, east of road near wire fence; iron post stamped "439"	439.344
Belmont, 6.6 miles north of, at forks of road, west of road, near wire fence corner; iron post stamped "434"	433.849
Luling, 3 miles south of, south of J. B. Wood's house and mail box, 1,000 feet south of, in forks of road (river road and bridge road); iron post stamped "394"	394.008
Luling, in southwest corner of park opposite freight station; iron post stamped "426"	410.708

Luling via road by Tilmon to Lockhart.

	Feet.
Luling, 3.6 miles northeast of, southwest corner of forks of Clear Fork road and Tilmon road; iron post stamped "413"	412.862
Luling, 9.4 miles northeast of, at forks of road 0.5 mile west of gin near negro's house, northeast corner; iron post stamped "388"	387.548
Tilmon, R. Robertson & Son's store, in front of gallery at northwest corner; iron post stamped "388"	387.257
Tilmon, 3 miles northwest of, 70 feet east of Plum Creek bridge, north of road; iron post stamped "390"	389.776
Seawillow, 0.5 mile northwest of, in front of house, 15 feet south of C. A. Rolsten's mail box, 3 feet north of gate; iron post stamped "462"	461.060
Seawillow, 2.95 miles northwest of, 4 miles southeast of Lockhart, 600 feet southeast of mail box 8 (Mrs. J. T. Martindale), 100 feet north of small bridge, 15 feet east of road, in limestone ledge; bronze tablet stamped "480"	479.344
Lockhart, in front of San Antonio & Aransas Pass Ry. station; top of rail	513.8
Lockhart, 30 feet south of Missouri, Kansas & Texas Ry. track, 200 feet west of transfer track of San Antonio & Aransas Pass Ry., 40 feet west of road crossing; iron post	504.683

Lockhart by road via Fentress to Luling.

Lockhart, 3.7 miles southwest of, 150 feet west of Clear Fork Creek, 0.25 mile west of Joe M. Horner's house, south of road; iron post stamped "489"	489.007
Lockhart, 5.1 miles southwest of, in fork of road, main road turns west, 500 feet east of Alex. Mahan's mail box; iron post stamped "610"	610.568
Lockhart, 9.7 miles southwest of, at forks (left-hand road goes to Luling and Prairie Lea, right hand goes to Fentress); iron post stamped "539"	539.494
Fentress, 75 feet northeast of Cumberland Presbyterian Church, in forks of road, 30 feet south of Lockhart-Kingsbury road, 40 feet north of Fentress-Luling road; iron post stamped "444"	444.091
Prairie Lea, 200 feet southeast of W. N. McKinney's Sons' store, 600 feet northwest of Methodist Church, 500 feet southwest of schoolhouse, at fence corner; iron post stamped "451"	451.255
Prairie Lea, 3.2 miles southeast of, at forks of road, at southeast corner, 30 feet northeast of mail box of P. A. Styles, 55; iron post stamped "460"	460.067
Luling, 1.5 miles northwest of, in forks at southeast fence corner, 30 feet east of mail box 7, 2,000 feet southeast of schoolhouse; iron post stamped "378"	378.427

Fentress along road via Martindale to San Marcos.

Fentress, 4.1 miles northwest of, at intersection of lane and main road, at northeast corner; iron post stamped "473"	473.283
Martindale, 200 feet southwest of Missionary Baptist Church, at corner of fence, 40 feet east of main road; iron post stamped "528"	527.631

	Feet.
Martindale, 1.9 miles northwest of, 250 feet east of Fuller's house, in forks of Rudsville and Fentress-San Marcos roads; iron post stamped "558"	557.865
San Marcos, 3.4 miles southeast of, at southeast corner of crossroads; iron post stamped "567"	567.471

San Marcos via Uhland to Lockhart.

San Marcos, 3.6 miles northeast of, 200 feet southwest of High Prairie schoolhouse, at fence corner; iron post stamped "598"	598.077
San Marcos, 6.2 miles northeast of, at intersection of Maxwell road, at southwest corner; iron post stamped "623"	623.05
San Marcos, 8.6 miles northeast of, at northwest corner of crossroads; iron post stamped "636"	635.896
Uhland, 0.5 mile southwest of, near mail box of E. F. Ranke, in forks of road; iron post stamped "644"	644.227
Uhland, 3.3 miles southeast of, at gate where telephone pole crosses road, west side of road; iron post stamped "611"	611.134
Lockhart, 2.8 miles southwest of, 0.25 mile east of Blank's gin, 80 feet north of crossing of Missouri, Kansas & Texas Ry., north of road; iron post stamped "557"	556.935
Lockhart, in front of Missouri, Kansas & Texas Ry. station; top of rail	518.18

Luling along San Antonio & Aransas Pass Ry. to point 3.5 miles southeast of Slayden.

Luling, in front of San Antonio & Aransas Pass Ry. station; top of rail	400.1
Luling, 3 miles southeast of, 30 feet north of road crossing at milepost 165; iron post stamped "347"	346.653
Andrews, in front of signboard; top of rail	339.6
Luling, 6.4 miles southeast of, in northeast corner of road crossing at milepost 162; iron post stamped "323"	322.954
Ottine, in front of station; top of rail	338.2
Ottine, 800 feet southeast of station, north corner of cattle-guard fence; iron post stamped "328"	328.058
Slayden, 500 feet northwest of station, at road crossing at end of switch, at north fence corner of cattle guard; iron post stamped "327"	326.948
Slayden, in front of station; top of rail	327.4
Slayden, 1.8 miles southeast of, at road crossing 1,500 feet southeast of milepost 156, at southeast corner; iron post stamped "305"	304.932

Seguin to Harwood along Galveston, Harrisburg & San Antonio Ry.

Seguin, opposite station; center of track	551.2
Elks siding, opposite signboard; center of track	544.3
Elks siding, 200 feet southeast of Neil's house, 1.5 feet from wire fence south of east headblock; iron post stamped "558"	550.237
Kingsbury, south of main track, 1.5 feet west of small park west of station; iron post stamped "614"	606.386
Kingsbury, in front of station; center of track	604.6
Sullivan siding, at southeast corner of railroad section 78, 40 feet west of headblock south end of switch; iron post stamped "473"	465.471

	Feet.
San Marcos River, in top of rock bridge seat north end of east pier; copper bolt stamped "398"	382.447
Luling, southwest corner of park opposite freight station; iron post stamped "426"	410.708
Ivy siding, southwest corner of right of way fence, 200 feet west of west end of siding, east of Luling-Harwood county road; iron post stamped "455"	439.397
Harwood, 100 feet west of station, 25 feet north of track, 2 feet west of west end of park; iron post stamped "476"	460.528

Buda to San Marcos along International & Great Northern R. R.

Kyle, 1 mile north of station, at Kyle and Austin public road crossing, in corner of right of way fence, 40 feet east of track, 30 feet north of road; iron post stamped "713"	707.726
Kyle, in front of station; center of track	713.7
Blanco river railroad bridge, in top of northeast end of north rock pier; copper bolt stamped "U. S. G. S. 636 B. M."	631.000
San Marcos River railroad bridge, in west end of north rock pier; copper bolt stamped "U. S. G. S. 583 B. M."	577.732
Mile board 215, south of road crossing near, west of track; iron post stamped "662"	656.801

San Marcos along Missouri, Kansas & Texas Ry. to Lockhart.

San Marcos River railroad bridge, in west end of north rock pier; copper bolt stamped "U. S. G. S. 583 B. M."	577.732
Mile board 1018, 10 feet west of ninth telegraph pole east of, 40 feet south of track, 30 feet east of wagon road; iron post	580.984
Maxwell, in front of station; top of rail	604.2
Maxwell, in front of station, 30 feet south of center of track; iron post	603.894
Clear Fork spur, at headblock; center of track	566.7
Clear Fork spur, 400 feet east of, 25 feet north of center of track, 50 feet south of San Marcos and Lockhart road crossing; iron post	569.726
Lockhart, in front of station; center of track	517.5
Lockhart, 30 feet south of Missouri, Kansas & Texas Ry. track, 200 feet west of transfer track of San Antonio & Aransas Pass Ry., 40 feet west of road; iron post	504.683

Lockhart to Luling along San Antonio & Aransas Pass Ry.

Cattle guard 40, 40 feet south of Hales road crossing, 15 feet west of track; iron post	487.810
Burdette siding, in front of platform; center of main track	457.7
Lockhart and Luling public road crossing, 25 feet east of track, 10 feet from fence; iron post	403.760

UVALDE QUADRANGLE.

Uvalde along Dry Frio Canyon road north 20.75 miles.

Uvalde, 4 miles northeast of, 20 feet northwest of gate at fork of Uvalde and Leaky (Frio Canyon) road; iron post stamped "1009"	1,000.516
Chilton ranch, 0.5 mile east of, in corner of fence 10 feet north of road to house; iron post stamped "1116"	1,108.250

	Feet.
Davenport south ranch, 0.25 mile south of, 35 feet east of gate, "Uvalde, 15 miles"; iron post stamped "1229"	1,221.122
Uvalde, 20.75 miles north of, 200 feet south of J. F. Kelley ranch, 10 feet west of gate; iron post stamped "1356"	1,348.084

Kelley ranch along Sabinal and Leaky road to Hackberry ranch.

Concan schoolhouse, 465 feet northeast of, 10 feet south of road, inside fence; iron post stamped "1252"	1,243.860
Florea ranch, 0.25 mile east of, 10 feet southwest of road to ranch, in corner of pasture; iron post stamped "1183"	1,174.860
Hackberry ranch, 600 feet northwest of, 7 feet east of large live oak tree at fork of Blanco Canyon road up Hackberry Creek; iron post stamped "1122"	1,113.980

Hackberry north along Blanco Canyon road to Enderle ranch.

Hackberry ranch, 4 miles north of, 500 feet south of Enderle ranch, 20 feet south of road; iron post stamped "1300"	1,291.792

Bench marks, Uvalde and Utopia road.

Blanco River, 0.75 mile northeast of, 50 feet north of gate; iron post stamped "1016"	1,007.881
E. D. Kelley's ranch, 250 feet northwest of, set inside house lot, and 20 feet east of gate; iron post stamped "1103"	1,094.805
Sabinal and Utopia road, 1.75 miles southwest of, junction of Uvalde road, 600 feet north of Sabinal River, 50 feet south of road, 2 feet north of small mesquite tree; iron post stamped "1121"	1,113.059

Bench mark on Ranch road via Baldwin tank.

Umlong ranch, 2.25 miles northwest of, 300 feet east of Frio River, 2.25 miles west of Baldwin tank, 50 feet north of gate on road; iron post stamped "1064"	1,055.938

Bench marks on Nueces Canyon road.

Benson Knob (Round Mountain), summit of; iron post stamped "1077"	1,069.006
Uvalde, 13 miles northwest of, 100 feet west of gate; iron post stamped "1045"	1,037.110
Uvalde, 18.8 miles northwest of, 0.33 mile southwest of Nueces River crossing, 50 feet north of gate on road to Francis Smith & Co.'s (Molesworth) ranch; iron post stamped "1126"	1,117.430

Laguna northeast 3.5 miles along Sycamore Creek ranch road.

Laguna, 1 mile northeast of, inside lot fence, 25 feet south of Francis Smith & Co.'s (Molesworth) ranch house; iron post stamped "1162"	1,153.950
Laguna, 3.5 miles northeast of, opposite yellow bank on creek 2.75 miles northeast of Francis Smith & Co.'s (Molesworth) ranch house, between road and creek; iron post stamped "1269"	1,261.181

Bench marks on Indian Creek ranch road.

	Feet.
T. J. Lewis's ranch, near the fork of Nueces River and Indian Creek, inside of lot fence, 25 feet north of house; iron post stamped "976"	967.867
William Lewis's ranch, 2.25 miles northeast of, in lot 40 feet south of Van Ham's lower windmill; iron post stamped "1164"	1,156.255
William Lewis's ranch, 5 miles north of, in lot 60 feet west of Van Ham's windmill; iron post stamped "1270"	1,262.207
William Lewis's upper ranch, 6 miles northeast of, 25 feet east of divide between Indian Creek and Dry Frio River, 10 feet south of road; iron post stamped "1502"	1,493.988
William Lewis's ranch, 8 miles north of, in small elm grove 40 feet east of road fork, 0.75 mile southeast of Francis Smith & Co.'s (Molesworth) windmill; iron post stamped "1327"	1,318.782
Francis Smith & Co.'s (Molesworth) windmill, on Indian Creek, 5 miles northeast of, 800 feet west of divide between Indian Creek and Dry Frio River, 50 feet north of gate in west face of Davenport's pasture; iron post stamped "1609"	1,600.886

Bench marks on Uvalde-Fort Clark (Brackettville) road.

Uvalde, 3.75 miles west of, by wire fence south of gate at end of lane; iron post stamped "935"	927.662
Uvalde, 8 miles west of, under cat-claw tree on north side of road, 50 feet east of asphalt mine; iron post stamped "919"	911.412
Uvalde, 12 miles west of, on saddle between 2 hills, 3.5 miles east of Carbonville (asphalt mine), 20 feet south of road; iron post stamped "955"	947.332

Uvalde southwest via Uvalde-Smythe and Nunn ranch road to Nunn & Smythe ranch.

Uvalde, 9 miles southwest of, 1.75 miles southwest of old Tom Nunn ranch, 18 feet west of gate between Tom Nunn and Nunn & Smythe pastures; iron post stamped "864"	856.351
Uvalde, 15 miles southwest of, in lot at Nunn & Smythe ranch house on Turkey Creek, 40 feet west of large gate; iron post stamped "848"	840.418

Uvalde southwest via Uvalde and Eagle Pass road 12.5 miles.

Uvalde, 5.75 miles west of, under wire fence 20 feet south of gate at forks of road to Mrs. Bates's ranch on Nueces River; iron post stamped "977"	969.655
Uvalde, 12.5 miles southwest of, 3.5 miles west of Nueces River, 30 feet north of road, near cluster of mesquite bushes, on divide between Mustang Creek and Windmill or Elm Creek; iron post stamped "889"	881.078

Uvalde southwest to Piper & West ranch (Hurd windmill) via road.

Uvalde, 10.5 miles southwest of, in corner of lot 20 feet west of Piper & West ranch house; iron post stamped "807"	799.584
Uvalde, 15.5 miles southwest of, Hurd windmill, Piper & West ranch, in northeast corner of house lot; iron post stamped "792"	783.971

Bench mark near Turk's ranch.

	Feet.
Turk's ranch, 0.75 mile northeast of, in large rock on east end of Sand Hill; bronze tablet stamped "868"	860.182

Uvalde southwest 16 miles on Wilderness Lake road.

Uvalde, 13 miles southwest of, in southeast corner of McDaniel's ranch-house lot; iron post stamped "767"	759.152
Uvalde, 16 miles southwest of, 3 miles west of McDaniel's ranch, 2.5 miles southwest of Habbey ranch, 60 feet west of road forks, 10 feet north of road; iron post stamped "806"	797.946

Uvalde south 16 miles on Carrizo Springs road.

Uvalde, 8 miles south of, 1.5 miles north of Pulliam's windmill and water hole, on high ridge, under a small mesquite tree, 10 feet west of road; iron post stamped "930"	922.319
Uvalde, 16 miles south of, 1.5 miles south of 7D ranch house, 20 feet southwest of gate; iron post stamped "748"	740.902

Uvalde toward Batesville along west side of Leona Creek.

Uvalde, 13 miles southwest of, summit of hill in northwest corner of Piper & Ellis's pasture, 2 miles west of gate on Uvalde and Batesville road; iron post stamped "964"	956.608
Uvalde, 16 miles south of, 1.25 miles south of Piper & Ellis's ranch house, rear corner of fence 55 feet east of gate; iron post stamped "763"	755.429
Uvalde, 4 miles south of, 10 feet east of gate; iron post stamped "890"	882.038
Uvalde, 8.75 miles south of, 10 feet east of road, under large mesquite tree; iron post stamped "864"	856.148
Uvalde, 13 miles south of, 1.75 miles north of Piper & Ellis's ranch house, 10 feet east of gate in fence between Piper & Ellis's ranch and 7D ranch; iron post stamped "833"	825.172

Ditch Road from Uvalde to Batesville, Friotown, and Pearsall along east side of Leona Creek.

Uvalde, 6 miles southeast of, 50 feet east of gate; iron post stamped "885"	877.093
Uvalde, 11 miles southeast of, 5 feet east of gate at Baylorsville settlement, on S. C. Bennett ranch; iron post stamped "826"	817.973
Uvalde, 21 miles southeast of, under tree 10 feet north of Leona Creek crossing; iron post stamped "753"	745.147

Lewis ranch south by Friotown and Pearsall road to Bates ranch.

Uvalde, 18.5 miles southeast of, 1.25 miles northwest of Lewis windmill, under a small mesquite tree 100 feet north of road, 225 feet west of Lewis ranch road; iron post stamped "891"	882.500
Uvalde, 25 miles southeast of, 2.5 miles southwest of Burt Hollingsworth's house, in northwest corner of house lot at the old Bates ranch (now Piper & Ellis), on Live Oak Creek; iron post stamped "748"	739.909

Lewis ranch north via Sabinal and Batesville road 6 miles.

	Feet.
Lewis ranch, south side of Frio River at crossing, in northwest corner of east house lot; iron post stamped "793"	785.387
Lewis ranch, 4 miles northeast of, 7 miles east of Englemann's ranch house, 60 feet north of intersection of Uvalde-Friotown-Pearsall road; iron post stamped "812"	804.090
Lewis ranch on Frio River, 6 miles north of, 3.5 miles south of Dr. Wish's ranch on the San Antonio road, 40 feet north of fork of road to Sabinal; iron post stamped "873"	865.42

Uvalde east along Friotown and Pearsall road to Englemann's.

Uvalde, 11 miles east of, 0.5 mile north of Englemann's house, 25 feet north of small house on north bank of Frio River; iron post stamped "864"	856.092

Uvalde east along Sabinal and San Antonio road.

Uvalde, 2.75 miles east of, 375 feet east of fork of Utopia road, near a large mesquite tree; iron post stamped "958"	949.736
Uvalde, 6.5 miles east of, 300 feet east of Frio River at old Moore ranch, 100 feet northeast of house; iron post stamped "917"	907.491
Sabinal, 5 miles west of, 200 feet south of W. A. Kelley's ranch house, under small mesquite tree; iron post stamped "931"	922.953

Sabinal to Uvalde along Galveston, Harrisburg & San Antonio Ry.

Blanco River, in top of coping, north end of rock pier of iron bridge; copper bolt stamped "942"	934.437
Uvalde, 12 miles east of, 20 feet east of the Uvalde and Utopia public road crossing, between tenth and eleventh telegraph poles west of mileboard 290; iron post stamped "987"	979.337
Mileboard 296, between eighth and ninth telegraph poles east of, on south side of track; iron post stamped "965"	956.996
Leona River bridge, in top of coping, north end of east rock pier; copper bolt stamped "937"	929.268
Uvalde, in front of station; top of tie	928.8
Uvalde, 30 feet east of courthouse; iron post stamped "910"	902.135
Uvalde, in rock east side of north entrance to courthouse; bronze tablet stamped "913"	905.256

Agua Fria, Alpine, Chisos Mountains, Marfa, Saratoga Mountain, Shafter, and Terlingua Quadrangles.

BREWSTER AND PRESIDIO COUNTIES.

The elevations in the following list are based on an aluminum tablet in the southeast corner stone of the county courthouse at Marfa, stamped "4695 MARFA," the elevation of which is accepted as 4,695.043 feet above mean sea level. This elevation was determined from Galveston, Harrisburg & San Antonio Railway levels, the height of the top of the rail in front of the station being accepted as 4,689 feet above mean sea level.

The leveling was done by M. S. Bright in 1901 and 1902, except for the greater portion in the Chisos Mountains quadrangle, which was done by Chester Irvine in 1902 and 1903 in cooperation with the University of Texas Mineral Survey.

All permanent bench marks dependent on this datum are stamped with the letters "MARFA" in addition to the figures of elevation. By railroad data a correction of about 9 feet should be added to these elevations to bring them in accord with those at El Paso determined by precise and double-rod primary leveling from San Diego, Cal.

MARFA QUADRANGLE.

Marfa south 21.5 miles.

	Feet.
Marfa, in southeast corner stone of county courthouse; aluminum tablet stamped "4695 MARFA"	4,695.043
Marfa, at front entrance to Murphy & Walker's brick storehouse; iron post stamped "4689 MARFA"	4,688.963
Marfa, 3 miles south of, summit of ridge, east side of road by wire fence; iron post stamped "4628 MARFA"	4,628.070
Marfa, 6.8 miles south of, in road forks; iron post stamped "4550 MARFA"	4,550.029
Marfa, 10 miles south of, west side of road, at west gate by wire fence; iron post stamped "4480 MARFA"	4,480.015
Marfa, 13 miles south of, summit of ridge, east side of road at fence corner; iron post stamped "4324 MARFA"	4,324.024
Marfa, 16.25 miles south of, west side of road, 5 feet west of gate post; iron post stamped "4261 MARFA"	4,260.947
Marfa, 19.5 miles south of, west side of road, 200 feet south of road crossing; iron post stamped "4198 MARFA"	4,198.141
Marfa, 21.5 miles south of, west side of road, in flat; iron post stamped "4114 MARFA"	4,114.199

SHAFTER QUADRANGLE.

Point 21.5 miles south of Marfa to point 6.25 miles south of Dysart.

Dysart, 7.25 miles north of, west side of road, 900 feet south of forks of same; iron post stamped "4024 MARFA"	4,024.148
Dysart, 3.8 miles north of, summit of ridge, west side of road; iron post stamped "3975 MARFA"	3,975.120
Dysart, 2 miles north of, summit of ridge, west side of road and 200 feet north of road forks; iron post stamped "3853 MARFA"	3,853.003
Dysart, post office (Alamito town), west side of road, at northeast corner of Carlos Aereray's storehouse; iron post stamped "3772 MARFA"	3,772.201
Dysart, 2.5 miles south of, in road forks; iron post stamped "3715 MARFA"	3,715.246
Dysart, 6.25 miles south of, in small valley, 12 feet west of road, 75 feet east of White Ridge; iron post stamped "3603 MARFA"	3,602.923

AGUA FRIA QUADRANGLE.

Point 6.25 miles south of Dysart to point 28 miles southeast of Dysart.

Dysart, 9.8 miles south of, 100 feet north of windmill, south side of road by wire fence; iron post stamped "3536 MARFA"	3,536.209
Dysart, 13 miles south of, south side of road in mound of stone; iron post stamped "3656 MARFA"	3,656.148

	Feet.
Dysart, 16.25 miles southeast of, on flat ridge, 4 feet south of road in mound of stone; iron post stamped "4071 MARFA"	4,071.189
Dysart, 18.8 miles southeast of, 6 feet east of road, 40 feet west of draw, in limestone outcrop; aluminum tablet stamped "4022 MARFA"	4,022.297
Dysart, 21.8 miles southeast of, 200 feet southwest of water tank, 8 feet west of road; iron post stamped "4133 MARFA"	4,133.184
Dysart, 25.25 miles southeast of, east foot of hill, west side of road; iron post stamped "4204 MARFA"	4,204.024
Dysart, 28 miles sotheast of, summit of ridge, east side of road in mound of stone; iron post stamped "4496 MARFA"	4,496.258

Adobe Walls north to near Neville ranch.

Adobe Walls, 2.25 miles north of, 25 feet west of the Alpine road at summit of flat divide; iron post stamped "3447 MARFA"	3,447.290
Adobe Walls, 5.5 miles north of, wire fence east and west, west side of road at west gate post; iron post stamped "3360 MARFA"	3,360.407
Adobe Walls, 8.5 miles north of, west side of road, in open flat, at mail box; iron post stamped "3301 MARFA"	3,301.368
Adobe Walls, 11.8 miles north of, 10 feet west of road; iron post stamped "3467 MARFA"	3,467.231
Butcherknife Wells, 11.8 miles south of, west side of road, at foot of hill; iron post stamped "3684 MARFA"	3,684.245
Butcherknife Wells, 8.5 miles south of, 4 feet west of road, on flat table land; iron post stamped "3849 MARFA"	3,849.423
Butcherknife Wells, 5.25 miles south of, 0.25 mile south of road forks, on spur of ridge, 8 feet east of road; iron post stamped "3917 MARFA"	3,917.443
Butcherknife Wells, 2. 5 miles south of, east side of road, south side of cluster of mesquite bushes; iron post stamped "3760 MARFA"	3,760.645
Butcherknife Wells, 790 feet north of windmill and 150 feet east of ranch house, west side of road by wire fence; iron post stamped "3798 MARFA"	3,798.449
Butcherknife Wells, 3.25 miles north of, 6 feet west of road; iron post stamped "3836 MARFA"	3,836.474
Butcherknife Wells, 6.25 miles north of, in road forks; iron post stamped "4009 MARFA"	4,009.460
The Two Windmills, 0.25 mile west of, 8 feet west of road; iron post stamped "4102 MARFA"	4,102.592
The Two Windmills, 3.25 miles north of, 2 feet east of new road and 4 feet west of old road; iron post stamped "4245 MARFA"	4,245.557

At Agua Fria Springs.

Agua Fria Springs, 12 feet north of springs, in limestone outcrop; bronze tablet stamped "3537 MARFA"	3,537.510

TERLINGUA QUADRANGLE.

Point 28 miles southeast of Dysart to Terlingua.

	Feet.
Dysart, 31.25 miles southeast of, on spur of ridge, 75 feet east of draw and 14 feet east of road; iron post stamped "4262 MARFA"	4,262.449
Dysart, 34.5 miles southeast of, 20 feet east of canyon, 2 feet west of road, in limestone outcrop; bronze tablet stamped "3808 MARFA"	3,808.174

	Feet.
Terlingua, 20.8 miles northwest of, in Fresno Canyon, about 0.7 mile north of Arroyo Segundo, west side of road, in large limestone bowlder outcrop; bronze tablet stamped "3402 MARFA"	3,402.185
Terlingua, 17.25 miles northwest of, on spur of ridge, 500 feet west of canyon, 20 feet west of road; iron post stamped "3119 MARFA"	3,119.328
Terlingua, 14 miles northwest of, summit of small sharp ridge, 500 feet east of canyon and 75 feet west of road forks, where main road to Terlingua leaves Fresno Creek; iron post stamped "2789 MARFA"	2,789.104
Terlingua, 11 miles northwest of, summit of sharp ridge, 60 feet west of road forks, south side of road; iron post stamped "2662 MARFA"	2,662.136
Terlingua, 7.8 miles west of, in draw 60 feet west of channel, 25 feet south of road, in limestone outcrop; bronze tablet stamped "2745 MARFA"	2,745.168
Terlingua, 5 miles by route south of, 0.65 foot west of canyon, 4 feet east of road, in mound of stone; iron post stamped "2634 MARFA"	2,634.219
Terlingua, 2.8 miles southeast of, summit of small ridge, 160 feet northeast of road forks, northwest side of road; iron post stamped "2816 MARFA"	2,816.244
Dewee's mine, in south wall of stone warehouse; aluminum tablet stamped "3201 MARFA"	3,201.369
Terlingua, in north wall of rock building utilized as post office and store of Marfa Maraposa Mining Co.; bronze tablet stamped "3272 MARFA"	3,272.449

Dewee's mine east and north to Colquitt-Tigner mine.

Dewee's mine, 2.8 miles east of, in road forks, in limestone outcrop; bronze tablet stamped "3066 MARFA"	3,066.468
Colquitt-Tigner mines, 125 feet southeast of rock building, in limestone ledge; bronze tablet stamped "3274 MARFA"	3,274.303

Point near Dewee's mine east and north to Adobe Walls Mountain.

McKinney Bros. mines, 1,200 feet southeast of, east side of draw, north side of road, at forks of same; iron post stamped "2722 MARFA"	2,722.443
Cigar Springs, 0.8 mile south of, 100 feet east of Alpine road and 15 feet west of Cigar Springs road; iron post stamped "2716 MARFA"	2,716.375
Cigar Springs, 3.8 miles north of, 10 feet west of road, 30 feet south of draw; iron post stamped "2671 MARFA"	2,671.308
Alvin Reed ranch (Rock corral), 1.5 miles north of, 400 feet south of road forks, west side of road at foot of hill; iron post stamped "2795 MARFA"	2,795.373
Alvin Reed ranch, 5 miles north of, 25 feet south of road, at foot of black hill; iron post stamped "3049 MARFA"	3,049.261
Adobe Walls and Spring, 0.25 mile west of, 15 feet west of road, at foot of small knoll; iron post stamped "3313 MARFA"	3,313.361

Point near Rock Corral northwest along road to Agua Fria Springs (line run twice).

Agua Fria Springs, 6.25 miles southeast of, 75 feet south of Terlingua Creek, 6 feet south of trail, at northwest corner of rock bluff; iron post stamped "2885 MARFA"	2,885.388
Agua Fria Springs, 3.25 miles southeast of, north side of draw, east foot of hill, 2 feet south of trail; iron post stamped "3175 MARFA"	3,175.309

Cigar Springs east to Joe Black Springs.

	Feet.
Cigar Springs, 2.8 miles east of, north side of road, on sharp rock ridge; iron post stamped "2577 MARFA"	2,577.265
Joe Black Springs, 0.25 mile west of, 60 feet north of road, 20 feet west of wire fence, at foot of rock bluff in sandstone rock; aluminum tablet stamped "2661 MARFA"	2,661.340

Pena Springs west and southwest to Rio Grande.

Pena Springs, 2 miles west of, summit of small divide, 40 feet northeast of road; iron post stamped "2415 MARFA"	2,415.611
Dewee's old smelter, 1.8 miles east of, in open flat, 12 feet south of road forks; iron post stamped "2344 MARFA"	2,344.621
Mexican settlement, 100 feet west of Terlingua Creek and 12 feet west of road, at double cottonwood tree; iron post stamped "2211 MARFA"	2,211.538

Rio Grande northwest to point near Terlingua.

Grand Canyon of Santa Helena, mouth of, in forks of Terlingua Creek and the Rio Grande, in rock bench; aluminum tablet stamped "2146 MARFA"	2,146.630
Grand Canyon, 5 miles north of, in road forks in open flat; iron post stamped "2316 MARFA"	2,316.624
Grand Canyon, 8.5 miles north of, 10 feet east of road, on side of knoll; iron post stamped "2516 MARFA"	2,516.771

Grand Canyon of Santa Helena east along road down Rio Grande to Cipriano Hernandes ranch.

Cipriano Hernandes ranch, 10 feet north of forks of road, 300 yards north of ranch house, in embedded bowlder; probably an aluminum tablet (hole was drilled to receive tablet, but there is no record in the Geographical Survey office that tablet has been set)	2,124.059

ALPINE QUADRANGLE.

Point near Neville ranch north of Alpine.

Neville ranch, 0.5 mile northwest of, 120 feet west of Calamity Creek, 8 feet west of road at foot of hill; iron post stamped "4362 MARFA"	4,362.557
Neville ranch, 4.25 miles north of, 60 feet south of creek, 6 feet east of road; iron post stamped "4498 MARFA"	4,498.677
Neville, 7.5 miles north of, 40 feet south of red gate, west side of road by wire fence; iron post stamped "4716 MARFA"	4,716.453
Neville ranch, 10.5 miles north of, 100 feet east of road, west side of rocky knoll in sandstone outcrop; bronze tablet stamped "4977 MARFA"	4,977.446
Alpine, 12.5 miles south of, at summit in gap, 12 feet west of road in volcanic outcrop; bronze tablet stamped "5192 MARFA"	5,192.373
Alpine, 10 miles southeast of, at summit in gap, 25 feet north of road in volcanic rock; bronze tablet stamped "5404 MARFA"	5,404.225
Alpine, 6.5 miles southeast of, summit in divide, 20 feet northeast of road in limestone outcrop; bronze tablet stamped "5255 MARFA"	5,255.545

	Feet.
Alpine, 3.5 miles southeast of, in forks of road; iron post stamped "4673 MARFA"	4,673.650
Alpine, at east entrance of county courthouse, in north end of third step; bronze tablet stamped "4476 MARFA"	4,476.715

Alpine west along Galveston, Harrisburg & San Antonio Ry. to point near Marfa.

Alpine, 3.8 miles west of, 50 feet north of railroad track, 20 feet south of public road, 5 feet east of gate; iron post stamped "4665 MARFA"	4,665.663
Toronto, in front of signboard; top of rail	4,735.2
Alpine, 6.8 miles west of, 30 feet southwest of milepost 616, 20 feet north of public road, in flint rock outcrop; bronze tablet stamped "4820 MARFA"	4,820.517
Alpine, 9.8 miles west of, 300 feet west of milepost 619, 50 feet north of public road, by wire fence, in sandstone rock; bronze tablet stamped "4964 MARFA"	4,964.764
Paisano, 1.5 miles west of, 150 feet south of railroad track, 65 feet north of public road, in limestone outcrop; bronze tablet stamped "4999 MARFA"	4,999.401
Paisano, 4 miles west of, 50 feet south of railroad track, 3 feet south of milepost 626; iron post stamped "4910 MARFA"	4,910.531
Nopal siding, 100 feet south of track, 10 feet east of gate; iron post stamped "4806 MARFA"	4,806.728
Marfa, 4 miles east of, 0.25 mile southwest of milepost 632, in road forks; iron post stamped "4813 MARFA"	4,813.683

CHISOS MOUNTAINS QUADRANGLE.

Joe Black Springs east to Gano Springs.

Joe Black Springs, 3.25 miles east of, 100 feet southeast of road and 50 feet southwest of creek, at foot of round hill; iron post stamped "2745 MARFA"	2,745.447
Joe Black Springs, 6.25 miles east of, 40 feet east of, 40 feet north of road in volcanic rock; aluminum tablet stamped "2901 MARFA"	2,901.394
Gano Springs, 3.5 miles west of, 40 feet south of road in sandstone outcrop; aluminum tablet stamped "3134 MARFA"	3,134.302
Gano Springs, 100 feet north of springs and 2,000 feet east of road forks, north side of draw; iron post stamped "3492 MARFA"	3,492.464

Gano Springs southwest via the Chimneys to Pena Springs.

Rock Hut, 1.8 miles south of, flat ridge, 25 feet east of road, in sandstone outcrop; aluminum tablet stamped "3731 MARFA"	3,731.560
Rock Hut, 5 miles south of, summit of divide, 20 feet east of Smugglers' trail, in flint rock outcrop; aluminum tablet stamped "3842 MARFA"	3,842.997
Burro Springs, 1 mile southwest of, 20 feet west of road, north bank of draw in bowlder outcrop; aluminum tablet stamped "2963 MARFA"	2,963.489
The Chimneys, 1.5 miles west of, 100 feet southwest of road, in sandstone outcrop on flat ridge; aluminum tablet stamped "2634 MARFA"	2,634.460

Gano Springs northeast via Neville Spring and Stroud's mail box to Bone Springs.

	Feet.
Gano Springs, 4.4 miles northeast of, on ridge 5 feet west of road, 300 feet east of creek; iron post stamped "3504 MARFA 1903"	3,504.420
Gano Springs, 7.4 miles northeast of, 5 feet south of road and about 0.5 mile southwest of red ridge; iron post stamped "3523 MARFA 1903"	3,523.128
Neville Spring, 4.3 miles west of, at Paint Gap crossroads; iron post stamped "3387 MARFA 1903"	3,386.873
Neville Spring, 0.4 mile west of, at forks of road, east side of drain; iron post stamped "3293 MARFA 1903"	3,293.028
Neville Spring, 2.6 miles northeast of, on end of ridge, 40 feet south of road, south bank of creek, 600 feet east of where road leaves creek bed; bronze tablet stamped "2968 MARFA 1903"	2,967.733
Neville Spring, 5.8 miles northeast of, 20 feet west of road, at summit of low ridge bearing east and west, 600 feet south of pasture gate; iron post stamped "2814 MARFA 1903"	2,813.827
Neville Spring, 8.5 miles northeast of, junction of Neville Spring, Marathon, and Boquillas-Marathon roads; iron post stamped "2828 MARFA 1903"	2,828.096

Stroud's mail box southeast along wagon road via Boquillas to Old Boquillas.

Stroud's mail box, 4.5 miles south of, 1.5 miles north of old goat ranch, in group of small hills, 30 feet west of road; bronze tablet stamped "2744 MARFA 1903"	2,744.080
McKinney Spring, 0.25 mile north of, 10 feet north of road; iron post stamped "2947 MARFA 1903"	2,946.863
McKinney Spring, 2.5 miles east of, north side of road, in cut for roadway, end of ridge; bronze tablet stamped "2994 MARFA 1903"	2,993.726
McKinney Spring, 5.5 miles southeast of, 10 feet south of road in small saddle, 700 feet south of where road crosses and leaves creek; iron post stamped "2732 MARFA 1903"	2,731.889
Boquillas, 3 miles north of, in ridge where road leaves creek, 8 feet west of road; bronze tablet stamped "2469 MARFA 1903"	2,468.903
Boquillas, southeast corner of adobe building, 100 feet northeast of Ernst's store and post office building; bronze tablet stamped "2133 MARFA 1903"	2,133.204
Boquillas, 1 mile east of, at forks, 6 feet south of road; mark on stone	2,255.77
Boquillas, 4.31 miles southeast of, at junction of roads in drain; iron post stamped "2029 MARFA 1903"	2,028.770
Old Boquillas, north side of road, on small ridge, 350 feet west of two old adobe houses; iron post stamped "1873 MARFA 1903"	1,873.103

Old Boquillas southwest to Big San Vincente Mountain, thence west to Hernandez ranch.

San Vincente, 1.5 miles northeast of, on west slope of small rocky hill, 10 feet east of road, 350 feet north of road forks, east side of Tornillo Creek; iron post stamped "1881 MARFA 1903"	1,880.773
San Vincente, 1.5 miles west of, 1,600 feet east of junction of roads on summit of ridge, 10 feet north of road, embedded bowlder; bronze tablet stamped "1965 MARFA 1903"	1,964.679

	Feet.
San Vincente, 3.8 miles west of, junction of roads on flat, embedded bowlder 10 feet west of road; bronze tablet stamped "1915 MARFA 1903"	1,915.023
San Vincente, 7.5 miles west of, 120 feet north of road, end of small rock ridge, at junction of drains; bronze tablet stamped "1998 MARFA 1903"	1,997.833
San Vincente, 10.5 miles west of, 10 feet west of road, 400 yards south of yellow bluff side of drain, embedded bowlder; bronze tablet stamped "2135 MARFA 1903"	2,134.740
Big San Vincente Mountain, north end of, summit of ridge, 15 feet west of road, in saddle; bronze tablet stamped "2385 MARFA 1903"	2,384.557
Big San Vincente Mountain, 1 mile west of, 2,000 feet south of, where road comes through small gap, east bank of dry wash, 10 feet west of road, between hills; bronze tablet stamped "2217 MARFA 1903"	2,216.994
Big San Vincente Mountain, 4 miles west of, on summit of flat ridge, 10 feet south of road; bronze tablet stamped "2325 MARFA 1903"	2,325.036
Big San Vincente Mountain, 7 miles west of, 1,800 feet east of road forks, slope of small hill in valley, 30 feet south of road; bronze tablet stamped "2138 MARFA 1903"	2,137.668
Big San Vincente Mountain, 10.5 miles west of, 3 miles east of Alvin Reed's spring, 10 feet north of road, on low ridge, between drains; bronze tablet stamped "2269 MARFA 1903"	2,268.778
Said Bend of Rio Grande, on end of ridge, west side of mouth of large drain, 30 feet west of road; bronze tablet stamped "2053 MARFA 1903"	2,052.560
Mexican settlement, 4 miles east of, 1 mile south of 4 blackjacks, south side of drain, 20 feet south of road; bronze tablet stamped "2140 MARFA 1903"	2,139.434
Mexican settlement, 1 mile east of, 40 feet northwest of forks of road, west bank of large drain, in embedded bowlder; probably a bronze or aluminum tablet	2,086.434[1]
Cipriano Hernandes ranch, 6 miles east of, 1 mile north of where road leaves Rio Grande and goes around hills, 10 feet south of road, summit of divide, in embedded bowlder; probably a bronze or aluminum tablet	2,251.788[1]
Cipriano Hernandes ranch, 3 miles east of, 20 feet south of road, summit of divide, in embedded bowlder, 1 by 3 by 2, 2 feet in ground; probably a bronze or aluminum tablet	2,134.431[1]

SARATOGA MOUNTAIN QUADRANGLE.

Near Stroud's ranch.

NOTE.—The following three elevations are means of direct and reverse lines.

Stroud's mail box, 1.8 miles north of, 20 feet east of road, on slope of small gravel hill; iron post stamped "2881 MARFA 1903"	2,881.256
Stroud's lower tank, 1,830 feet north of, 10 feet east of road; iron post stamped "2753 MARFA 1903"	2,753.011
Bone Springs, about 1 mile south of, 3 miles north of Stroud's lower tank, 20 feet west of road; iron post stamped "2641 MARFA 1903"	2,640.996

[1] Holes were drilled to receive the tablets for the last three bench marks, but the Survey has no record that the tablets were set.

Chispa and Van Horn Quadrangles.

EL PASO COUNTY.

The elevations in the following list were determined by primary leveling extended from Fay, and are based on the elevation of the top of the rail in front of the station at Fay, accepted as 4,010 feet. Several bench marks near Van Horn were redetermined by the Coast and Geodetic Survey in 1911, and their elevations were found to be about 8 feet too low.

The leveling was done by Chester Irvine in 1903, and by Stuart T. Penick in 1905.

CHISPA QUADRANGLE.

Fay, Galveston, Harrisburg & San Antonio Ry. station, across country to Van Horn, Texas & Pacific Ry. station.

	Feet.
Fay, in front of station signboard; top of rail	4,010.0
Fay, west side of gate, 150 feet east of station sign post, 800 feet east of section house; iron post stamped "4007 VAN HN 1903"	4,007.332
Cox ranch, 600 feet east of residence, east side of gate; iron post stamped "3948 VAN HN 1903"	3,947.779

VAN HORN QUADRANGLE.

Van Horn east along Texas & Pacific Ry. to Plateau.

Van Horn, in front of Texas & Pacific Ry. station; top of rail	4,039.7
Van Horn, 240 feet west of station, 100 feet south of main track, 4 feet south of telegraph pole; iron post stamped "4039 VAN HN 1903" (C. & G. S. unadjusted elevation, 1911, 4,047.915 feet)	4,039.353
Van Horn, 3 miles east of, 0.25 mile north of railway, 15 feet north of wagon road, 10 feet south of dry ditch; iron post stamped "3922 VAN HN 1903"	3,921.967
Van Horn, 6 miles east of, 700 feet east of milepost 796, 50 feet south of track, 10 feet south of wagon road; iron post stamped "3867 VAN HN 1903" (C. & G. S. unadjusted elevations, 1911, 3,875.380 feet)	3,866.928
Wild Horse, in front of section house; top of rail	3,844.
Wild Horse, 1 mile east of, 1,400 feet east of milepost 733, 100 feet south of track, 10 feet north of wagon road; iron post stamped "3826 VAN HN 1903" (C. & G. S. unadjusted elevation, 1911, 3,834.385 feet)	3,825.857
Wild Horse, 4 miles east of, 1,300 feet east of milepost 730, 60 feet south of track, 10 feet north of wagon road; iron post stamped "3840 VAN HN 1903" (C. & G. S. unadjusted elevations, 1911, 3,848.862 feet)	3,840.149
Plateau, 1.5 miles west of, 100 feet south of track, 1,000 feet east of milepost 727, 10 feet north of wagon road; iron post stamped "3889 VAN HN 1903" (C. & G. S. unadjusted elevations, 1911, 3,897.953 feet)	3,889.134
Plateau, in front of section house; top of rail	3,936.4

Plateau north along highways via Marley's ranch to Marley tank.

	Feet.
Plateau, 1.5 miles north of, 200 feet west of forks of roads, 100 feet south of tank, 10 feet south of forks of road; iron post stamped "3916 VAN HN 1903"	3,915.951
Plateau, 4.5 miles north of, 5 feet west of road; iron post stamped "3865 VAN HN 1903"	3,865.147
Marley's ranch, 300 feet north of corral, 300 feet east of residence; iron post stamped "3759 VAN HN 1903"	3,759.186
Marley's ranch, 2.25 miles north of, forks of road; iron post stamped "3779 VAN HN 1903"	3,779.144
Marley's ranch, 5.8 miles north of, 5 feet east of road to Luckett's camp; iron post stamped "3899 VAN HN 1903"	3,898.937
Marley's ranch, 8.8 miles north of, junction of Marley's ranch tank road and Old Salt road; iron post stamped "3969 VAN HN 1903"	3,969.051
Marley's tank, 2,400 feet east of, 15 feet south of Figure 4-Van Horn road; iron post stamped "VAN HN 1903 4148"	4,148.138

Marley's tank southwest via Marley lower ranch to Van Horn.

Marley's tank, 2.5 miles west of, 10 feet east of road on summit of small ridge; iron post stamped "3899 VAN HN 1903"	3,899.132
Marley's lower ranch, 1.8 miles northeast of, 10 feet east of road; iron post stamped "3708 VAN HN 1903"	3,708.352
Marley's lower ranch, 1.6 miles south of, at forks of road; iron post stamped "3663 VAN HN 1903"	3,663.116
Marley's lower ranch, 4.6 miles south of, 10 feet east of road; iron post stamped "3715 VAN HN 1903"	3,714.921
Marley's lower ranch, 7.6 miles south of, 0.5 mile east of small hill, 5 feet east of road; iron post stamped "3833 VAN HN 1903"	3,832.961
Marley's lower ranch, 11.5 miles south of, 30 feet west of forks of road; iron post stamped "4115 VAN HN 1903"	4,115.171
Van Horn, 4.4 miles north of, 15 feet east of road; iron post stamped "4081 VAN HN 1903"	4,081.283
Van Horn, 1.5 miles north of, 200 feet southwest of tank, 5 feet east of road; iron post stamped "4074 VAN HN 1903"	4,074.172

Van Horn west along Texas & Pacific Ry. to Allamore, thence north along road via Sulphur and Cannon ranches to Figure 2 ranch.

Van Horn, 3.1 miles west of, 400 feet northeast of Texas & Pacific Ry. milepost 745, 10 feet north of wagon road; iron post stamped "4239 VAN HN 1903" (C. & G. S. unadjusted elevation, 1911, 4,247.567 feet)	4,238.911
Van Horn, 5.5 miles west of, 1,200 feet northwest of railway trestle 375, 10 feet south of wagon road; iron post stamped "4395 VAN HN 1903" (C. & G. S. unadjusted elevation, 1911, 4,403.829 feet)	4,395.032
Allamore, 20 feet east of section house; iron post stamped "4603 VAN HN 1903" (C. & G. S. unadjusted elevation, 1911, 4,612.283 feet)	4,603.317
Pump station, southeast corner of fence, 150 feet southwest of well; iron post stamped "4702 VAN HN 1903"	4,701.635
Millican upper ranch, 0.5 mile north of, forks of road, on flat; iron post stamped "4865 VAN HN 1903"	4,865.172
Hazel mine, 60 feet east of road, 30 feet southwest of old wooden building; iron post stamped "4906 VAN HN 1903"	4,905.952

	Feet.
Sulphur ranch, 200 feet north of residence, west side of gate; iron post stamped "4461 VAN HN 1903"	4,461.304
Sulphur ranch, 2.5 miles north of, 0.25 mile north of old tank, 600 feet north of road forks, 10 feet west of Salt Flat-Van Horn road; iron post stamped "4290 VAN HN 1903"	4,289.742
Sulphur ranch, 5.5 miles north of, 20 feet east of road, east side of drain; iron post stamped "4048 VAN HN 1903"	4,048.117
Sulphur ranch, 8.5 miles north of, 10 feet east of road; iron post stamped "3806 VAN HN 1903"	3,806.178
Sulphur ranch, 11.6 miles north of, 2,400 feet north of road forks, 20 feet east of road, in drain; iron post stamped "3625 VAN HN 1903"	3,625.138
Sulphur ranch, 14.5 miles north of, 0.5 mile west of large lake, 0.5 mile south of Cannon windmills, 10 feet west of wagon road; iron post stamped "3648 VAN HN 1903"	3,647.867
Figure 2 ranch, 3.8 miles south of, 0.5 mile west of north end of lake, 10 feet west of wagon road; iron post stamped "3581 VAN HN 1903"	3,581.211
Figure 2 ranch, 1,200 feet south of windmills, 20 feet west of road, corner of fence; iron post stamped "3585 VAN HN 1903"	3,585.136

Salt Lake east to Marley's lower ranch.

Canons double wells, 1.5 miles northwest of, 10 feet north of road; iron post stamped "3579 VAN HN 1903"	3,578.089
Canons double wells, 2.5 miles east of, summit of small hill on flat, 10 feet west of road; iron post stamped "3622 VAN HN 1903"	3,622.272
Canons double wells, 5.5 miles east of, 10 feet west of road; iron post stamped "3670 VAN HN 1903"	3,669.817
Canons double wells, 8.5 miles east of, 10 feet south of road; iron post stamped "3763 VAN HN 1903"	3,762.873

Point 1.25 miles east of Wild Horse Section House north along Salt Flat road and Valentine road 4 miles, thence west across country to a point 6 miles east of Van Horn.

Wildhorse, 3 miles northeast of, 2.5 miles east of Medley's ranch, 0.8 mile north of crossroads, 20 feet west of Salt Flat-Valentine road; iron post stamped "3763 VAN HN 1905"	3,762.913
Wildhorse, 4 miles north of, 4 miles west of Salt Flat-Valentine road, 3 miles north of Medley's ranch; iron post stamped "3793 VAN HN 1905"	3,792.884

Point 3 miles northeast of Wildhorse, north to Medley's lower ranch, thence southeast to Jones's gate, thence southwest to starting point.

Wildhorse, 5.5 miles north of, 2.5 miles south of Medley's lower ranch, 30 feet east of Salt Flat-Valentine road; iron post stamped "3729 VAN HN 1905"	3,729.189
Medley's lower ranch, 1,200 feet south of house, 20 feet west of Salt Flat road; iron post stamped "3700 VAN HN 1905"	3,700.487
Medley's lower ranch, 3.25 miles southeast of, 3 miles northwest of Jones's pasture gate; iron post stamped "3726 VAN HN 1905"	3,726.139
Jones's pasture gate, 12 feet north of, 10 feet east of road; iron post stamped "3782 VAN HN 1905"	3,782.564
Jones's pasture gate, 3 miles west of, 15 feet north of road; iron post stamped "3782 VAN HN 1905"	3,781.825

Medley's lower ranch northeast to Bean's ranch, thence west to point 1.5 miles south of Bean's three wells.

	Feet.
Medley's lower ranch, 3 miles north of, 20 feet west of Salt Flat-Valentine road; iron post stamped "3679 VAN HN 1905"	3,679.254
Bean's ranch, 600 feet west of, 10 feet south of road; iron post stamped "3665 VAN HN 1905"	3,664.790

Point 2 miles east of Canon's double wells southeast to tank, thence east to Bean's pasture gate, thence northeast to Taylor-Salt Flat Road.

Canon's tank, 600 feet south of, in rock; bronze tablet stamped "3641 VAN HN 1905"	3,640.298
Bean's pasture gate, 20 feet south of, 10 feet southwest of road; bronze tablet stamped "3645 VAN HN 1905"	3,645.495

Point 5.8 miles east of Canon's double wells north via Canon's new well, foot of mountains, Freeman well and John's well to Figure 2 ranch.

Canon's new well, 600 feet north of; iron post stamped "3669 VAN HN 1905"	3,668.789
Canon's new well, 3.25 miles east of, 0.5 mile northwest of small hill; iron post stamped "3892 VAN HN 1905"	3,892.443
Freeman well, 600 feet south of, 300 feet south of road; iron post stamped "3694 VAN HN 1905"	3,694.423
Drift wells, 1.25 miles north of, in forks of road; iron post stamped "3664 VAN HN 1905"	3,663.987
John's well, 2.5 miles southeast of, 0.5 mile east of long, low ridge; iron post stamped "3939 VAN HN 1905"	3,938.055
John's well, 600 feet north of; iron post stamped "3784 VAN HN 1905"	3,783.619
Threemile well, 30 feet south of tank, 20 feet north of road; iron post stamped "3644 VAN HN 1905"	3,644.542

Cerro Alto Quadrangle.

EL PASO COUNTY.

The elevations in the following list are based upon an elevation at El Paso determined by precise leveling from Yuma, Ariz., and are derived through checked leveling on El Paso quadrangle by the United States Reclamation Service and the Geological Survey.

The leveling was done by M. S. Bright in 1901. It was based on an assumed railroad datum at San Elizario, and the stamped elevations are about 7 feet too low.

CERRO ALTO QUADRANGLE.

Point 15 miles east of Clint east 8.5 miles along north Salt Lake road to point near Coyote tanks, thence north 22 miles along dim roads and trails to South Sacramento road, thence east along South Sacramento road and across country 16 miles to saddle at head of draw, thence south 11 miles across country, thence west to Rockhouse draw and southwest down draw to point near Coyote tanks.

	Feet.
San Elizario, 15.7 miles east of, lat. 31° 40′; long. 105° 59′. North side of road in mound of stone; iron post stamped "4162"	4,168.613
San Elizario, 21.5 miles east of, lat. 31° 40′; long. 105° 43′. East side of saddle, south side of road at angle to northeast, in mound of stone; iron post stamped "4523"	4,529.387

	Feet.
Lat. 31° 43′; long. 105° 51′. West slope of hill, 4 feet east of road, 350 feet east of draw, in mound of rock; iron post stamped "4709"	4,715.564
Lat. 31° 45′; long. 105° 54′. East side of draw at angle to northwest, side of wagon trail, by stone pier; iron post stamped "4984"	4,990.743
Lat. 31° 48′; long. 105° 54′. Summit of divide, east side of wagon trail; iron post stamped "5147"	5,155.916
Lat. 31° 52′; long. 105° 53′. 200 feet east of draw, on point of small ridge, S. 45° E. of Cerro Alto Mountain; iron post stamped "5318"	5,324.846
Lat. 31° 57′; long. 105° 53′. 4 feet south of South Sacramento road east and west, 400 feet west of draw; iron post stamped "5266"	5,272.819
Lat. 31° 57′; long. 105° 47′. In forks of road; iron post stamped "5020"	5,026.865
Lat. 31° 56′; long. 105° 43′. At toe of slope, north side of draw; iron post stamped "4850"	4,857.035
Lat. 31° 56′; long. 105° 40′. Summit of ridge northwest and southeast, south about 10° west of Cerro Alamo, in forks of wagon trail; iron post stamped "4788"	4,794.991
Lat. 31° 54′; long. 105° 37′. Head of draw, summit in gap; iron post stamped "4860"	4,867.169
Lat. 31° 51′; long. 105° 37′. On ridge, south side of draw, about 100 feet west of east point of ridge; iron post stamped "4597"	4,604.160
Lat. 31° 48′; long. 105° 38′. North side of slope near summit of big ridge east and west, 275 feet south of white flag on bush; iron post stamped "4686"	4,693.351
Lat. 31° 45′; long. 105° 39′. Top of small knoll 50 feet north of small draw east, 100 feet south of white flag; iron post stamped "4605"	4,612.273
Lat. 31° 47′; long. 105° 43′. Iron post stamped "4890 S E"	4,896.841
Lat. 31° 47′; long. 105° 47′. East side of draw north and south at gap leading east; iron post stamped "5108"	5,114.614
Lat. 31° 43′; long. 105° 49′. East edge of old road north and south; iron post stamped "4774"	4,780.518

Bench mark marked "4605," lat. 31° 45′, long. 105° 39′, south to lat. 31° 34′, long. 105° 42′, thence northwest to bench mark "4523," about 3 miles southwest of Coyote tanks.

Lat. 31° 41′; long. 105° 40′. Twenty-five feet south of Salt Lakes road east and west, north of gap in mountain; iron post stamped "4672"	4,679.361
Lat. 31° 37′; long. 105° 41′. West side of draw north on bench on small spur of ridge, south of Cerro Alamo; iron post stamped "5061"	5,068.349
Lat. 31° 34′; long. 105° 42′. Summit of flat ridge east and west, white flag; iron post stamped "5106"	5,113.449
Lat. 31° 35′; long. 105° 45′. Twenty-five feet east of mound of stone on edge of high rock bluff, in limestone outcrop; bronze tablet stamped "5219"	5,226.842
Lat. 31° 35′; long. 105° 48′. West slope of hill, 4 feet north of mound of stone, in limestone outcrop; bronze tablet stamped "4587"	4,594.677
Lat. 35° 36′; long. 105° 51′. Flat draw southwest, east side, on slight ridge, north edge of wagon trail; iron post stamped "4331"	4,338.747
Lat. 31° 38′; long. 105° 53′. On southeast edge of main draw to southwest; iron post stamped "4404"	4,411.645

EL PASO QUADRANGLE.

EL PASO COUNTY.

The elevations in the following list were determined by primary leveling extended from El Paso, based on an elevation determined by precise leveling. The line from El Paso northeast along the El Paso & Southwestern Railroad of this list is part of a single spur line to Alamogordo, N. Mex. The line from San Elizario east along the Salt Lake road is connected with El Paso by leveling of the Reclamation Service, not included in the list. For additional elevations see precise-level list.

The leveling was done by M. S. Bright in 1901, by Fred McLaughlin in 1907, and by K. W. Trimble in 1909.

EL PASO QUADRANGLE.

El Paso north along highway to Newman's ranch.

	Feet.
El Paso, west end lower stone steps, north entrance of city hall; aluminum tablet stamped "3698"	3,709.307
El Paso, 500 feet north of crossing of El Paso & Southwestern Ry. and Fort Bliss street car line, at road crossing; top of rail	3,720.1
Fort Bliss, 0.3 mile northwest of, in northeast corner of Ford's brick saloon; aluminum tablet stamped "3889"	3,900.546
Taylor ranch, 30 feet west of road, north of fence, on old railroad grade; iron post stamped "3875"	3,886.658
Taylor ranch, 2.2 miles north of, in top step of northeast entrance of two-story ranch house, 400 feet west of road; aluminum tablet stamped "3946"	3,957.828
Taylor ranch, 5.2 miles north of, 15 feet west of road, near old reservoir; iron post stamped "4000"	4,011.638
Newman's ranch, 1.25 miles south of, in fence corner east of road; iron post stamped "4029"	4,040.721

El Paso northeast along El Paso & Southwestern R. R. to State line (part of single unchecked line to point 10 miles southeast of Alamogordo, N. Mex.).

El Paso, intersection of El Paso & Southwestern R. R. and Mace Avenue; top of rail	3,728.3
El Paso, Galveston, Houston & San Antonio Ry. crossing, in north end of switch block; nail marked "3703"	3,703.05
El Paso, 3 miles northeast of, at milepost 3, 50 feet west of railroad; iron post stamped "3805"	3,804.699
Fort Bliss, south side of water tower; top of bolt marked "3894.9 B.M."	3,894.91
Fort Bliss, 1.3 miles northeast of, at milepost 6, 50 feet west of railroad; iron post stamped "3873"	3,873.281
Tobin, at milepost 9, 50 feet west of railroad; iron post stamped "3899"	3,898.501
Franklin, 0.2 mile southwest of, at milepost 12, 50 feet west of railroad; iron post stamped "3919"	3,919.382

	Feet.
Newman, N. Mex., 4 miles southwest of, at milepost 15, 50 feet west of El Paso & Southwestern R. R.; iron post stamped "3982"	3,981.900
Newman, N. Mex., 1 mile southwest of, at milepost 18, 50 feet west of railroad; iron post stamped "4000"	3,999.907
Texas-New Mexico boundary line, opposite line post; top of rail	3,999.727

Clint post office (near San Elizario) east along North Salt Lake Road 15 miles to elevation of 4,100 feet.

Clint, northwest corner of post-office building; iron post stamped "3625 SE"	3,631.615
Clint, in front of station; top of rail	3,634.2
Clint, 4.75 miles east of, in road forks; iron post stamped "3993 SE"	3,999.825
Clint, 10.5 miles east of, 400 feet west of angle in road to southeast, north side of road; iron post stamped "4039 SE"	4,045.577

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

BULLETIN 469

RESULTS OF SPIRIT LEVELING IN NORTH DAKOTA

1897 TO 1910, INCLUSIVE

R. B. MARSHALL, CHIEF GEOGRAPHER

WASHINGTON
GOVERNMENT PRINTING OFFICE
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GEOLOGICAL SURVEY BENCH MARKS.

A, Tablet used in cooperating States. The State name is inserted at *G*.
B and *D*, Copper temporary bench mark, consisting of a nail and copper washer.
A, *C*, and *E*, Tablets for stone or concrete structures.
F, Iron post used where there is no rock.

RESULTS OF SPIRIT LEVELING IN NORTH DAKOTA, 1897 TO 1910, INCLUSIVE.

R. B. MARSHALL, Chief Geographer.

INTRODUCTION.

Scope of the work.—All results of spirit leveling in North Dakota previously published by the United States Geological Survey and all the results of later work are included in this report, rearranged by quadrangles. Elevations are based on heights of bench marks along precise level lines of the Coast and Geodetic Survey as adjusted in 1907, and on checked primary leveling of the Missouri River Commission. The elevations of bench marks in the Pingree quadrangle are based on railroad datum, and are therefore only approximate.

Personnel.—The field work previous to 1903 was done under the general direction of J. H. Renshawe, geographer; that for 1903 to 1906, inclusive, under H. M. Wilson, geographer; and the later work under E. C. Barnard and Sledge Tatum, geographers, under the general direction of R. B. Marshall, chief geographer. The names of the various levelmen are given in the introduction to each list. The office work of computation, adjustment, and preparation of lists was done mainly by S. S. Gannett, geographer, and D. H. Baldwin, topographer, and since 1907 under the general direction of E. M. Douglas, geographer.

Classification.—No precise leveling has been done by the United States Geological Survey in this State. For primary lines standard Y levels are used; lines are run in circuits or are closed on precise lines, with an allowable closing error in feet represented by $0.05\sqrt{D}$, in which D is the length of the circuit in miles, sufficient care being given the work to maintain this standard. For circuit closures careful office adjustments are made, the small outstanding errors being distributed over the lines.

Bench marks.—The standard bench marks are of two forms. The first form is a circular bronze or aluminum tablet (*C* and *E*, Pl. I), 3.5 inches in diameter and one-quarter inch thick, having a 3-inch stem, which is cemented in a drill hole in solid rock in the wall of some public building, a bridge abutment, or other substantial masonry structure. The second form (*F*, Pl. I), used where masonry

or rock is not available, consists of a hollow wrought-iron post 3.5 inches in outer diameter and 4 feet in length. The bottom is spread out to a width of 10 inches, in order to give a firm bearing on the earth. A bronze or aluminum-bronze cap is riveted over the top of the post, which is set about 3 feet in the ground. A third style of bench mark with abbreviated lettering (*B* and *D*, Pl. I), is used for unimportant points. This consists of a special copper nail 1.5 inches in length driven through a copper washer seven-eighths inch in diameter. The tablets, as well as the caps on the iron posts, are appropriately lettered, and for cooperating States the fact of such cooperation is indicated by the addition of the State name (*G*, Pl. I).

The numbers stamped on the bench marks described in the following pages represent the elevations to the nearest foot as determined by the levelman. These numbers are stamped with $\frac{3}{16}$-inch steel dies on the tablets or post caps, to the left of the word "FEET." The office adjustment of the notes and the reduction to mean sea level datum may so change some of the figures that the original markings are 1 or 2 feet in error. It is assumed that engineers and others who have occasion to use the bench-mark elevations will apply to the Director of the United States Geological Survey, at Washington, D. C., for the adjusted values, and will use the markings as identification numbers only.

Datum.—All United States Geological Survey elevations are referred to mean sea level, which is the level that the sea would assume if the influence of winds and tides were eliminated. This level is not the elevation determined from the mean of the highest and the lowest tides, nor is it the half sum of the mean of all the high tides and the mean of all the low tides, which is called the half-tide level. *Mean sea level is the average height of the water, all stages of the tide being considered.* It is determined from observations made by means of tidal gages placed at stations where local conditions, such as long, narrow bays, rivers, and like features, will not affect the height of the water. To obtain even approximately correct results these observations must extend over at least one lunar month, and if accuracy is desired they must extend over several years. At ocean stations the half-tide level and the mean sea level usually differ but little. It is assumed that there is no difference between the mean sea level as determined from observations in the Atlantic Ocean, the Gulf of Mexico, or the Pacific Ocean.

The connection with tidal stations for bench marks in certain areas that lie at some distance from the seacoast is still uncertain, and this fact is indicated by the addition of a letter or word to the right of the word "DATUM" on tablets or posts. For such areas corrections for published results will be made from time to time as the precise-level lines of the United States Geological Survey or other Government organizations are extended.

Topographic maps.—Maps of the following quadrangles wholly or partly in North Dakota have been published by the United States Geological Survey up to May 1, 1911. They may be obtained, except as noted, for 5 cents each or $3 a hundred, on application to the Director of the Survey, at Washington, D. C.

Bismarck.
Casselton.
Columbia (S. Dak.-N. Dak.).[1]
Eckelson.
Edgeley.[2]
Ellendale 30′ (S. Dak.-N. Dak.).[3]
Ellendale 15′ (N. Dak.-S. Dak.).[3]
Fargo (N. Dak.-Minn.).
Fullerton.[4]
Glendive (Mont.-N. Dak.).
Hecla (S. Dak.-N. Dak.).[1]
Jamestown.
Lamoure 30′.[4]
Lamoure 15′.[4]
Monango.[2]
Oakes.[4]
Pingree.
*Savo (S. Dak.-N. Dak.).[1]
Tower.
Wahpeton (N. Dak.-Minn.).
Wyndmere.

PRIMARY LEVELING.

Wahpeton and Wyndmere Quadrangles.

RANSOM, RICHLAND, AND SARGENT COUNTIES.

The elevations in the following list are based on three bench marks in the vicinity of Fairmount, determined by precise leveling of the Coast and Geodetic Survey.

The leveling in the Wahpeton quadrangle was done in 1902 by W. R. Saxton; that in the Wyndmere quadrangle was done in 1904 by J. G. Staack and M. A. Steel.

WAHPETON QUADRANGLE.

Wahpeton west 1 mile, thence north to south boundary of T. 134 N., thence west to east boundary of R. 51 W., thence north to sec. 6, T. 135 N., R. 46 W., thence south to Wahpeton.

	Feet.
Wahpeton, in front of Northern Pacific Ry. station; top of rail	960.0
Wahpeton, southeast corner of courthouse yard; iron post, stamped "964 W"	964.930
T. 132 N., R. 48 W., quarter corner on east side of sec. 12, about 1 mile west of Wahpeton, north side of road, 170 yards east of Northern Pacific Ry. tracks; iron post stamped "958 W"	959.244
Lehigh, T. 133 N., R. 47 W., northwest corner of sec. 18, east side of road, 50 feet south of Chicago, Milwaukee & St. Paul Ry. track, at intersection with range line; iron post stamped "955 W"	955.869
T. 133 N., R. 48 W., northwest corner of sec. 6, southeast corner of cross-roads; iron post stamped "949 W"	948.813
T. 133 N., R. 49 W., northwest corner of sec. 4, southeast corner of cross-roads, at fence corner; iron post stamped "970 W"	971.078

* Out of print.

[1] Hecla and Savo sheets, on scale of 1 : 62500, have been reduced and form parts of Columbia sheet, on scale of 1 : 125000.

[2] Monango sheet, on scale of 1 : 62500, has been reduced and forms part of Edgeley sheet, on scale of 1 : 125000.

[3] Ellendale 15′ sheet, on scale of 1 : 62500, has been reduced and forms part of Ellendale 30′ sheet, on scale of 1 : 125000.

[4] Oakes, Fullerton, and Lamoure 15′ sheets, on scale of 1 : 62500, have been reduced and form parts of Lamoure 30′ sheet, on scale of 1 : 125000.

	Feet.
T. 133 N., R. 50 W., northwest corner of sec. 6, southeast corner of crossroads; iron post stamped "1046 W"	1,046.467
T. 134 N., R. 50 W., southwest corner of sec. 7, about 50 feet northeast of crossroads; iron post stamped "1043 W"	1,043.692
T. 135 N., R. 50 W., 10 rods west of quarter corner on north side of sec. 17, south side of road; iron post stamped "1037 W"	1,037.940
T. 135 N., R. 49 W., north side of sec. 19, 50 feet south of section line, west side of railroad crossing on Great Northern Ry. track; iron post stamped "960 W"	961.338
T. 134 N., R. 49 W., north township line, 20 feet south of Great Northern Ry. crossing, on west side of track; iron post stamped "957 W"	958.390
NOTE.—This bench mark is on a single spur line 3 miles south of the preceding bench mark.	
T. 135 N., R. 48 W., north side of sec. 20, south of railroad crossing, west side of Chicago, Milwaukee & St. Paul track, 20 feet south of section line; iron post stamped "934 W"	934.972
T. 134 N., R. 48 W., northeast corner of sec. 5, southwest corner of crossroads; iron post stamped "933 W"	934.016
NOTE.—This bench mark is on a single spur line 3 miles south of the preceding bench mark.	
Wahpeton west to sec. 7, T. 132 N., R. 49 W., thence south to southwest corner of sec. 31, thence east to northeast corner of sec. 1, T. 131 N., R. 48 W., thence south 6 miles to northeast corner of sec. 1, T. 130 N., R. 48 W.	
T. 132 N., R. 48 W., quarter corner on west side of sec. 7, southeast side of crossroads; iron post stamped "963 W"	964.102
T. 132 N., R. 50 W., quarter corner on east side of sec. 12; iron post stamped "974 W"	974.522
T. 131 N., R. 50 W., northeast corner of sec. 1, southwest corner of crossroads; iron post stamped "979 W"	979.830
T. 131 N., R. 49 W., northeast corner of sec. 1, southwest corner of crossroads; iron post stamped "966 W"	967.481
T. 131 N., R. 48 W., northeast corner of sec. 1, southwest side of crossroads; iron post stamped "965 W"	966.131
T. 130 N., R. 48 W., northeast corner of sec. 1, southwest corner of crossroads; iron post stamped "979 W" (redetermined by Coast and Geodetic Survey)	980.101
Breckenridge south along section line 2 miles west of east side of R. 47 W. to north side of T. 130 N., thence west to northwest corner of sec. 6, T. 130 N., R. 49 W., thence south 6 miles west to sec. 34, T. 130 N., R. 47 W., thence north to T. 131 N.	
T. 130 N., R. 49 W., southeast corner of crossroads, sec. 2; iron post stamped "985 W"	986.245
T. 130 N., R. 50 W., northeast corner of sec. 1, southwest side of crossroads; iron post stamped "1028 W"	1,028.600

WYNDMERE QUADRANGLE.

Northeast corner of sec. 1, T. 130 N., R. 50 W., via Minneapolis, St. Paul & Sault Ste. Marie and Great Northern Rys. to Cayuga.

Lidgerwood, 5.5 miles east of, 12 feet west of section line between secs. 13 and 14, T. 130 N., R. 50 W., 12 feet west of Minneapolis, St. Paul & Sault Ste. Marie Ry. track; iron post	1,108.177
Lidgerwood, 2.5 miles east of, northwest corner of sec. 16, T. 130 N., R. 51 W., 15 feet east of county road, 30 feet south of Minneapolis, St. Paul & Sault Ste. Marie Ry.; iron post	1,133.971
Lidgerwood, in front of station: top of rail	1,091.0

Point 1 mile west of Ligderwood south on section line to Great Northern Ry.

	Feet.
T. 130 N., R. 52 W., secs. 14 and 15, 12 feet east of road on section line, 12 feet north of Great Northern Ry.; iron post stamped "Sta. 30-1115"....	1,116.356
Geneseo, 2 miles east of, 0.5 mile east of center of sec. 15, T. 130 N., R. 52 W., on east side of county road, 48 feet north of Great Northern Ry.; iron post....	1,136.592
T. 130 N., R. 52 W., 8 feet west of road on line between secs. 14 and 15, 1 mile west from Geneseo, 10 feet north of Great Northern Ry.; iron post..	1,166.590

Cayuga north on range line to northwest corner of sec. 7, T. 131 N., R. 53 W., thence east 1 mile and north 1 mile, thence east on line between Tps. 131 and 132 N., to northeast corner of sec. 1, R. 51 W.

T. 130 N., R. 54 W., northeast corner of sec. 1, 1 mile north of Ransom, southwest corner crossroads; iron post....	1,142.096
T. 131 N., R. 54 W., southeast corner of sec. 1, 6 miles north of Ransom, northwest corner crossroads; iron post....	1,105.526
T. 132 N., R. 53 W., southwest corner of sec. 34, 5 miles south of Delamere, 40 feet northeast of center of crossroads; iron post....	1,081.855
T. 131 N., R. 53 W., northeast corner of sec. 1, 4.5 miles south and 6 miles west of Wyndmere, southwest corner of crossroads; iron post....	1,076.365
T. 131 N., R. 52 W., northwest corner of sec. 3, 4.5 miles south and 3 miles west of Wyndmere; iron post....	1,089.457
T. 132 N., R. 52 W., southeast corner of sec. 36, 4.5 miles south of Wyndmere, northwest corner of crossroads; iron post....	1,066.494
T. 131 N., R. 51 W., northwest corner of sec. 3, 4.5 miles south and 3 miles east of Wyndmere, 40 feet south of bridge across Rice River, on east side of county road; iron post....	1,017.439
T. 132 N., R. 51 W., southeast corner of sec. 36, 4.5 miles south and 6 miles east of Wyndmere, northwest corner of crossroads; iron post....	1,035.365

Northeast corner of sec. 1, T. 131 N., R. 51 W., north on range line to bench mark at northeast corner of sec. 19, T. 133 N., R. 51 W.

T. 132 N., R. 51 W., southeast corner of sec. 13, 1.5 miles south of and 6 miles east of Wyndmere; iron post....	1,037.053
T. 133 N., R. 50 W., northwest corner of sec. 19, 5 miles east and 4 miles north of Wyndmere, southeast corner of crossroads; iron post....	1,046.105

Ransom west on section line 1 mile south of township line to southwest corner of sec. 6, T. 130 N., R. 54 W., thence north on range line to Milnor.

T. 131 N., R. 55 W., southeast corner of sec. 36, 6 miles west and 1 mile north of Ransom, northwest corner of crossroads; iron post....	1,200.852
T. 131 N., R. 55 W., 100 feet south of northeast corner of sec. 24, 7 miles south and 2 miles west of Milnor, northwest corner of crossroads; iron post....	1,196.897
T. 132 N., R. 55 W., southeast corner of sec. 36, 4 miles south and 2 miles west of Milnor, northwest corner of crossroads; iron post....	1,078.952
T. 132 N., R. 54 W., 600 feet south of northwest corner of sec. 19, 2 miles west and 1.5 miles south of Milnor, east side of north-south road, north side of east-west road; iron post....	1,176.670
Milnor, T. 132 N., R. 54 W., center of sec. 9, west corner of bank of Sargent Co., northwest end of second step; tablet....	1,098.799

Milnor, east along Northern Pacific Ry. and highways to southeast corner of sec. 36, T. 133 N., R. 51 W.

T. 132 N., R. 53 W., northwest corner of sec. 8, 11 miles west of Wyndmere, north side of track, east side of county road; iron post....	1,078.751
Delamere, sec. 4, T. 132 N., R. 53 W., 60 feet north and 33 feet west of northeast corner of station; iron post....	1,066.847

	Feet.
T. 132 N., R. 52 W., northwest corner of sec. 7, 6 miles west of Wyndmere, 10 feet south of track, east side of county road; iron post	1,063.770
T. 132 N., R. 52 W., northwest corner of sec. 10, 3 miles west of Wyndmere, 40 feet south of track, west of county road; iron post	1,062.303
Wyndmere, Earl school building, south end door sill, main entrance; tablet	1,065.259
T. 133 N., R. 51 W., southeast corner of sec. 36, 1 mile north and 5 miles east of Wyndmere, northwest corner of crossroads; iron post	1,046.489
T. 130 N., R. 54 W., 3 miles west of Ransom, near large pile of rocks, 130 paces west of northeast corner of sec. 9; iron post	1,171.049
T. 132 N., R. 51 W., 160 paces west of northeast corner of sec. 4, 2.8 miles east and 1 mile north of Wyndmere, south side of road; iron post	1,058.011

Northeast corner of sec. 6, T. 133 N., R. 50 W., along township line west to point 0.5 mile west of northeast corner of sec. 4, T. 133 N., R. 54 W., thence north to line of T. 135 N., thence east to northeast corner of sec. 1, T. 134 N., R. 51 W., thence south to southwest corner of sec. 7, T. 134 N., R. 50 W.

T. 133 N., R. 51 W., northwest corner of sec. 3, 7 miles north and 2 miles east of Wyndmere, southeast corner of crossroads; iron post	1,055.406
T. 134 N., R. 52 W., southeast corner of sec. 36, 7 miles north and 1 mile west of Wyndmere, northwest corner of crossroads; iron post	1,072.156
T. 133 N., R. 52 W., southwest corner of sec. 3, 7 miles north and 4 miles west of Wyndmere, southeast corner of crossroads; iron post	1,072.878
T. 133 N., R. 52 W., northeast corner of sec. 6, 7 miles north and 5 miles west of Wyndmere, south side of county road, west side of railroad, at fence corner; iron post	1,083.718
T. 134 N., R. 53 W., 300 feet north of township line, near southwest corner of sec. 34, 7 miles north and 8 miles west of Wyndmere, east side of north-south road; iron post	1,076.136
T. 134 N., R. 53 W., southeast corner of sec. 32, south side of east-west road; iron post	1,075.853
T. 133 N., R. 54 W., northeast corner of sec. 1, 30 feet west of range line; iron post	1,076.724
T. 134 N., R. 54 W., 0.5 mile south of center of sec. 33, 10 feet north of corner fence post; iron post	1,079.372
T. 134 N., R. 54 W., southeast corner of sec. 16, northwest corner of crossroads; iron post	1,070.296
T. 134 N., R. 54 W., northeast corner of sec. 4, southwest corner of crossroads; iron post	1,072.029
T. 134 N., R. 53 W., west side of railroad where it cuts township line between Tps. 134 and 135 N., 0.4 mile east of northwest corner of sec. 6; iron post	1,072.749
T. 135 N., R. 53 W., southeast corner of sec. 33, 10 feet north of corner fence post, northwest corner of crossroads; iron post	1,070.276
T. 135 N., R. 53 W., at southeast corner of sec. 36, 221 feet north of crossroads; iron post	1,072.836
T. 134 N., R. 52 W., northwest corner of sec. 4, 10 feet west of corner fence post, southeast corner of crossroads; iron post	1,066.440
T. 134 N., R. 51 W., northwest corner of sec. 3, southeast corner of crossroads; iron post	1,052.872
T. 135 N., R. 51 W., southeast corner of sec. 36, northwest corner of crossroads; iron post	1,043.177
T. 135 N., R. 52 W., southeast corner of sec. 35, northwest corner of crossroads; iron post	1,066.558

Pingree Quadrangle.

FOSTER AND STUTSMAN COUNTIES.

The elevations in the following list are based on the top of the rail of the Northern Pacific Ry. track in front of Jamestown station, the railroad company's elevation for which, 1,407.5 feet, was accepted.

The leveling was done in 1897 by Alfred Tyler.

PINGREE QUADRANGLE.

Bench marks established at land corners by lines of leveling which follow highways, mostly along section lines.

	Feet.
T. 141 N., R. 62 W., northwest corner of sec. 30; iron post stamped "JMTN 1455"	1,454.842
T. 141 N., R. 63 W., northwest corner of sec. 30; iron post stamped "JMTN 1435"	1,434.524
T. 141 N., R. 64 W., southwest corner of sec. 19; iron post stamped "JMTN 1529"	1,529.436
T. 141 N., R. 65 W., southwest corner of sec. 19; iron post stamped "JMTN 1645"	1,644.770
T. 141 N., R. 62 W., northwest corner of sec. 6; iron post stamped "JMTN 1511"	1,511.248
T. 142 N., R. 63 W., southwest corner of sec. 31; iron post stamped "JMTN 1465"	1,465.183
T. 142 N., R. 64 W., southwest corner of sec. 31; iron post stamped "JMTN 1550"	1,550.337
T. 142 N., R. 65 W., southwest corner of sec. 31; iron post stamped "JMTN 1646"	1,645.786
T. 142 N., R. 62 W., northwest corner of sec. 6; iron post stamped "JMTN 1541"	1,540.995
T. 143 N., R. 63 W., southwest corner of sec. 31; iron post stamped "JMTN 1522"	1,521.976
T. 143 N., R. 64 W., southwest corner of sec. 31; iron post stamped "JMTN 1533"	1,533.092
T. 143 N., R. 65 W., southwest corner of sec. 31; iron post stamped "JMTN 1515"	1,514.751
T. 143 N., R. 62 W., northwest corner of sec. 6; iron post stamped "JMTN 1525"	1,524.545
T. 144 N., R. 63 W., southwest corner of sec. 31; iron post stamped "JMTN 1523"	1,522.739
T. 144 N., R. 65 W., southwest corner of sec 35; iron post stamped "JMTN 1574"	1,574.348
T. 144 N., R. 66 W., southeast corner of sec. 36; iron post stamped "JMTN 1605"	1,605.235
T. 144 N., R. 62 W., northwest corner of sec. 6; iron post stamped "JMTN 1507"	1,507.490
T. 145 N., R. 63 W., southwest corner of sec. 31; iron post stamped "JMTN 1523"	1,523.393
T. 145 N., R. 64 W., northwest corner of sec. 6; iron post stamped "JMTN 1526"	1,525.686
T. 145 N., R. 64 W., southwest corner of sec. 32; iron post stamped "JMTN 1526"	1,525.908
T. 145 N., R. 65 W., southwest corner of sec. 32; iron post stamped "JMTN 1569"	1,569 172

	Feet.
T. 146 N., R. 62 W., northwest corner of sec. 6; iron post stamped "JMTN 1475"	1,474.761
T. 146 N., R. 63 W., northwest corner of sec. 6; iron post stamped "JMTN 1497"	1,497.127
T. 146 N., R. 64 W., northwest corner of sec. 6; iron post stamped "JMTN 1578"	1,578.112
T. 146 N., R. 65 W., northwest corner of sec. 5; iron post stamped "JMTN 1521"	1,520.948

Bismarck and New Salem Quadrangles.

BURLEIGH AND MORTON COUNTIES.

The elevations in the following list are based upon bench marks of the Missouri River Commission as given in the report of the Chief of Engineers, United States Army, for 1894, pages 1761–1765, corrected by the 1907 adjustment of the Coast and Geodetic Survey. The orthometric correction has also been applied to these elevations.

The leveling was done in 1905 by T. R. Lynch.

BISMARCK QUADRANGLE.

Bismarck east along township line to Menoken, thence north through range 76 to corner of secs. 8, 9, 16, and 17, T. 140 N., R. 78 W., thence west along section line to Missouri River.

	Feet.
Bismarck, about 1 mile below Bismarck Bridge, on east bank of Missouri River, 850 feet from river on bench north of Northern Pacific track; Missouri River Commission bench mark 186,2, plotted on chart 116 of Missouri River	1,667.636
T. 138 N., R. 80 W., northwest corner of sec. 2; iron post stamped "1734"	1,733.276
T. 139 N., R. 79 W., southwest corner of sec. 31; iron post stamped "1655"	1,654.345
T. 139 N., R. 79 W., southeast corner of sec. 33; 10 paces south and 10 paces east of section mound; iron post stamped "1683"	1,682.166
T. 139 N., R. 78 W., southwest corner of sec. 31; iron post stamped "1680"	1,679.337
T. 139 N., R. 78 W., southwest corner of sec. 33; iron post stamped "1759"	1,758.100
T. 139 N., R. 78 W., near northwest corner of sec. 21; iron post stamped "1695"	1,694.181
T. 139 N., R. 78 W., northwest corner of sec. 4; 5 paces southeast of; iron post stamped "1770"	1,768.859
T. 140 N., R. 78 W., southwest corner of sec. 9; 10 paces southwest of; iron post stamped "1999"	1,998.009
T. 140 N., R. 79 W., 15 paces northwest of southeast corner of sec. 10; iron post stamped "2063"	2,062.417
T. 140 N., R. 80 W., 15 paces northwest of southeast corner of sec. 12; iron post stamped "1985"	1,983.879
T. 140 N., R. 80 W., sec. 10, 1,850 paces west of southwest corner, on section line; iron post stamped "1843"	1,842.557
T. 140 N., R. 81 W., 15 paces west of southeast corner of sec. 12; iron post stamped "1927"	1,926.596
Square Butte Creek, 3.5 miles north of mouth of, on east bank of Missouri River, on high point in front of butte 1,400 feet from river, 750 feet east of wagon road; Missouri River Commission bench mark 183,2, plotted on chart 114 of Missouri River	1,802.955

Missouri River Commission bench mark 188/1 near corner of secs. 4, 5, 8, and 9, T. 137 N., R. 80 W., southwest to southwest corner of sec. 31, T. 137 N., R. 81 W.

	Feet.
Fort Lincoln, 3.5 miles south of, by road, on west bank of Missouri River about 1,400 feet back from high-cut bank of river, 700 feet from wagon road and northwest from Riverside Ranch; Missouri River Commission bench mark 188/1, plotted on chart 117	1,728.202
T. 137 N., R. 81 W., quarter corner on south side of sec. 13; iron post stamped "1702"	1,701.346
T. 137 N., R. 81 W., 10 paces north of southeast corner of sec. 16; iron post stamped "1765"	1,764.342
T. 136 N., R. 82 W., 15 paces southeast from northwest corner of sec. 2, on standard parallel; iron post stamped "1759"	1,757.706

Corner of Tps. 135 and 136 N., Rs. 81 and 82 W., east along township line to Missouri River.

Tps. 135 and 136 N., Rs. 81 and 82 W., 10 paces south of corner; iron post stamped "1944"	1,943.467
T. 136 N., R. 81 W., 15 paces northwest of southwest corner of sec. 34; iron post stamped "1902"	1,902.244
T. 136 N., R. 80 W., 10 paces south and 20 paces west of southwest corner of sec. 31; iron post stamped "2040"	2,038.810
T. 136 N., R. 80 W., 20 paces east and 10 paces south of southwest corner of sec. 34; iron post stamped "1914"	1,912.772
T. 135 N., R. 80 W., 270 paces south and 115 paces west of northeast corner of sec. 1, on north bank of large coulee; iron post stamped "1802"	1,801.393
T. 136 N., R. 70 W., southwest corner of sec. 33, between section mound pits; iron post stamped "1746"	1,744.970
Glencoe, 4 miles south of, on right bank of Missouri River, 800 feet from river, south side of lower of two small coulees; Missouri River Commission bench mark 194/2, plotted on chart 120	1,638.925

Rockhaven along Missouri River northwest 5 miles.

Rockhaven, on right bank of Missouri River, 200 feet above mouth of coulee, 350 feet from river, 400 feet from log house, on west side of wire fence; Missouri River Commission bench mark 184/1, plotted on chart 114	1,658.412
T. 140 N., R. 81 W., sec. 31, southwest corner; iron post stamped "2021"	2,020.046

Southwest corner of T. 138 N., R. 81 W., east along section line to Missouri River at old Fort Lincoln.

T. 138 N., R. 81 W., 10 paces east and 10 paces north of southwest corner of sec. 18; iron post stamped "1918"	1,916.791
T. 138 N., R. 81 W., 10 paces west and 10 paces south of southwest corner of sec. 16; iron post stamped "1939"	1,938.253
T. 138 N., R. 81 W., 275 paces west of quarter corner of secs. 14 and 23, on Creamery Road, near corner fence post; iron post stamped "1763"	1,762.367

NEW SALEM QUADRANGLE.

Corner of secs. 8, 9, 16, and 17, T. 136 N., R. 82 W., south along section line to corner of secs. 32 and 33, T. 136 N., R. 82 W., and secs. 4 and 5, T. 135 N., R. 82 W.

T. 136 N., R. 82 W., 10 paces west and 10 paces north of southeast corner of sec. 8; iron post stamped "1815"	1,814.265
T. 136 N., R. 82 W., 370 paces north of southwest corner of sec. 33; iron post stamped "2226"	2,225.014

Corner of secs. 3 and 4, T. 139 N., R. 82 W., and secs. 34 and 35, T. 140 N., R. 82 W., south 9 miles along section line.

	Feet.
T. 139 N., R. 82 W., 209 paces north of northeast corner of sec. 3; iron post stamped "1956"	1,955.252
T. 139 N., R. 82 W., 12 paces east and 7 paces south of northwest corner of sec. 14; iron post stamped "1897"	1,896.614
T. 139 N., R. 82 W., 75 paces east of southwest corner of sec. 23, on high bluff north of Heart River and Northern Pacific Ry.; iron post stamped "1829"	1,828.334
T. 139 N., R. 82 W., 725 paces south of sec. 35, 190 paces south of east-west public road, 40 paces east of north-south road; iron post stamped "2001"	1,999.688
T. 138 N., R. 82 W., southwest corner of sec. 14, 6 paces south and 4 paces west of section stone; iron post stamped "1863"	1,862.242

Blue Butte, Elbowoods, and Ryder Quadrangles—Fort Berthold Indian Reservation.

McLEAN, WALLACE, AND WARD COUNTIES.

The elevations in the following list are based on Missouri River Commission levels plus 0.755 foot, in accord with the 1907 adjustment at Elk Point, S. Dak., and minus 0.700 foot orthometric correction, leaving a total correction of +0.055 foot.

The work was done by the General Land Office. The iron posts at township corners are similar to those of the Geological Survey but are 1 foot shorter. They are 3.5 inches in diameter and 3 feet long; the bottoms are split and expanded to 10 inches, the tops are capped with brass plates appropriately lettered, and the interiors are filled with concrete. The iron section corner posts, which are pointed, are 3 feet long and 1 inch in diameter. They are filled with cement, capped, and driven 28 inches in the ground. Elevations are in general stamped on the brass caps.

The leveling was done in 1910 by H. L. Baldwin.

ELBOWOODS QUADRANGLE.

Missouri River Commission bench mark 153/2 southeast 3 miles to line between Tps. 149 and 150 N., thence east along township line to quarter corner between secs. 3 and 34.

	Feet.
Missouri River, east bank, at upper end of "The Slide," on high point 150 feet southeast from wagon road; Missouri River Commission bench mark 153/2	1,799.020
T. 150 N., R. 90 W., quarter corner of secs. 30 and 31; temporary bench mark on top of stone	2,026.16
T. 150 N., R. 90 W., quarter corner of secs. 31 and 32; on top of stone	2,034.34
Tps. 149 and 150 N., R. 90 W., corner of secs. 4, 5, 32, and 33; top of stone	2,000.74
Tps. 149 and 150 N., R. 90 W., quarter corner of secs. 4 and 33; top of stone	1,958.33
Tps. 149 and 150 N., R. 90 W., corner of secs. 3, 4, 33, and 34; on stone	2,006.61
Tps. 149 and 150 N., R. 90 W., quarter corner of secs. 3 and 34; on stone	2,034.73
Tps. 149 and 150 N., R. 90 W., corner of secs. 2, 3, 34, and 35; on stone	2,019.49
Tps. 149 and 150 N., Rs. 89 and 90 W., standard township corner; iron post stamped "1979"	1,977.913
Tps. 149 and 150 N., R. 89 W., quarter corner of secs. 6 and 31; top of stone	1,989.93
Tps. 149 and 150 N., R. 89 W., corner of secs. 5, 6, 31, and 32; top of stone	1,970.28

	Feet.
Tps. 149 and 150 N., R. 89 W., quarter corner of secs. 5 and 32; top of stone..	1,954.09
Tps. 149 and 150 N., R. 89 W., corner of secs. 4, 5, 32, and 33; top of stone..	1,962.20
Tps. 149 and 150 N., R. 89 W., quarter corner of secs. 4 and 33; top of stone..	1,974.08
Tps. 149 and 150 N., R. 89 W., corner of secs. 3, 4, 33, and 34; top of stone..	1,955.65

Point 0.5 mile east of secs. 9 and 10, T. 152 N., R. 89 W., west along north boundary of Fort Berthold Indian Reservation and section line to corner of Tps. 152 and 153 N., Rs. 89 and 90 W., thence south to corner Tps. 151 and 152 N., Rs. 89 and 90 W.

T. 152 N., R. 89 W., secs. 9 and 10, on reservation boundary at intersection with section line; top of stone	2,079.76
T. 152 N., R. 89 W., secs. 8 and 9, at intersection of section line with reservation boundary; top of stone	2,078.40
T. 152 N., R. 89 W., secs. 7 and 8, at intersection of section line with reservation boundary; top of stone	2,108.19
T. 152 N., Rs. 89 and 90 W., intersection of range line with north boundary of reservation; stone marker	2,115.65
T. 152 N., Rs. 89 and 90 W., 1 foot south of stone marking intersection of range line with north boundary of reservation; iron post stamped "2117"	2,115.798
T. 152 N., Rs. 89 and 90 W., corner of secs. 7, 12, 13, and 18; iron section post stamped "2129"	2,128.24
T. 152 N., Rs. 89 and 90 W., quarter corner of secs. 13 and 18; iron section post stamped "2117"	2,115.92
T. 152 N., Rs. 89 and 90 W., corner of secs. 13, 18, 19, and 24; iron section post stamped "2109"	2,108.41
T. 152 N., Rs. 89 and 90 W., quarter corner between secs. 19 and 24; iron section post stamped "2047"	2,046.23
T. 152 N., Rs. 89 and 90 W., corner of secs. 19, 24, 25, and 30; iron section post stamped "2002"	2,000.78
T. 152 N., Rs. 89 and 90 W., quarter corner between secs. 25 and 30; iron section post stamped "1943"	1,941.91
T. 152 N., Rs. 89 and 90 W., corner of secs. 25, 30, 31, and 36; iron section post stamped "1938"	1,937.68
Tps. 151 and 152 N., Rs. 89 and 90 W., corner of; iron post stamped "1994".	1,993.811

Tps. 150 and 151 N., Rs. 88 and 89 W., west along township line to corner of Tps. 150 and 151, Rs. 89 and 90 W., thence north along range line to corner of Tps. 151 and 152 N., Rs. 89 and 90 W., thence west along township line to corner of secs. 3, 4, 33, and 34, R. 91 W., thence west along township line to quarter corner between secs. 5 and 32, Tps. 151 and 152 N., R. 92 W.

Tps. 150 and 151 N., Rs. 88 and 89 W.; iron post stamped "2079"	2,078.397
Tps. 150 and 151 N., R. 89 W., corner of secs. 1, 2, 35, and 36; iron section post stamped "2063"	2,062.07
Tps. 150 and 151 N., R. 89 W., quarter corner between secs. 2 and 35; iron section post stamped "2064"	2,063.21
Tps. 150 and 151 N., R. 89 W., corner of secs. 2, 3, 34, and 35; iron section post stamped "2093"	2,092.86
Tps. 150 and 151 N., R. 89 W., corner of secs. 3, 4, 33, and 34; iron section post stamped "2131"	2,130.78
Tps. 150 and 151 N., R. 89 W., quarter corner between secs. 4 and 33; iron section post stamped "2157"	2,155.96
Tps. 150 and 151 N., R. 89 W., corner of secs. 4, 5, 32, and 33; iron section post stamped "2149"	2,148.16
Tps. 150 and 151 N., Rs. 89 and 90 W., 2 feet north of township corner; iron post stamped "2181"	2,180.830

	Feet.
T. 151 N., Rs. 89 and 90 W., quarter corner between secs. 31 and 36; iron section post stamped "2182"	2,181.37
T. 151 N., Rs. 89 and 90 W., corner of secs. 25, 30, 31, and 36; iron section post stamped "2196"	2,195.59
T. 151 N., Rs. 89 and 90 W., quarter corner between secs. 25 and 30; iron section post stamped "2204"	2,203.85
T. 151 N., R. 89 W., secs. 19 and 24; iron section post stamped "2156"	2,155.66
T. 151 N., R. 89 W., corner of secs. 13, 18, 19, and 24; iron section post stamped "2151"	2,150.20
T. 151 N., R. 89 W., quarter corner between secs. 13 and 18; top of iron section post stamped "2137"	2,136.31
T. 151 N., R. 89 W., corner of secs. 7, 12, 13, and 18; iron section post	2,117.36
T. 151 N., R. 89 W., quarter corner between secs. 7 and 12; iron section post stamped "2083"	2,082.15
T. 151 N., R. 89 W., corner of secs. 1, 6, 7, and 12; iron section post	2,062.71
T. 151 N., R. 89 W., quarter corner between secs. 1 and 6; iron section post stamped "2025"	2,024.26
Tps. 151 and 152 N., Rs. 89 and 90 W., corner of; iron post stamped "1994"	1,993.811
Tps. 151 and 152 N., R. 90 W., quarter corner between secs. 1 and 36; iron section post stamped "2025"	2,024.51
Tps. 151 and 152 N., R. 90 W., corner of secs. 1, 2, 35, and 36; iron section post stamped "2014"	2,013.77
Tps. 151 and 152 N., R. 90 W., quarter corner between secs. 2 and 35; iron section post stamped "1977"	1,976.36
Tps. 151 and 152 N., R. 90 W., corner of secs. 2, 3, 34, and 35; iron section post stamped "1989"	1,988.92
Tps. 151 and 152 N., R. 90 W., quarter corner between secs. 3 and 34; iron section post stamped "1991"	1,990.32
Tps. 151 and 152 N., R. 90 W., corner of secs. 3, 4, 33, and 34; iron section post	1,993.29
Tps. 151 and 152 N., R. 90 W., quarter corner between secs. 4 and 33; iron section post stamped "1983"	1,982.24
Tps. 151 and 152 N., R. 90 W., corner of secs. 4, 5, 32, and 33; iron section post stamped "1992"	1,991.94
Tps. 151 and 152 N., R. 90 W., quarter corner between secs. 5 and 32; iron section post stamped "1945"	1,944.71
Tps. 151 and 152 N., R. 90 W., corner of secs. 5, 6, 31, and 32; iron section post stamped "1959"	1,958.74
Tps. 151 and 152 N., R. 90 W., quarter corner between secs. 6 and 31; iron section post stamped "1903"	1,902.18
Tps. 151 and 152 N., Rs. 90 and 91 W., witness corner 16 inches north of township corner stone; iron post stamped "1874"	1,873.777
Tps. 151 and 152 N., R. 91 W., witness corner to corner of secs. 1, 2, 35, and 36; iron section post stamped "1887"	1,886.87
Tps. 151 and 152 N., R. 91 W., witness corner to corner of secs. 2, 3, 34, and 35; iron section post stamped "1832"	1,831.71
Tps. 151 and 152 N., R. 91 W., witness corner to corner of secs. 3, 4, 33, and 34; iron post stamped "1842"	1,842.00
Tps. 151 and 152 N., R. 91 W., witness corner to corner of secs. 4, 5, 32, and 33; iron section post stamped "1837"	1,835.50
Tps. 151 and 152 N., R. 91 W., corner of secs. 5, 6, 31, and 32; iron section post stamped "1806"	1,805.00
Tps. 151 and 152 N., Rs. 91 and 92 W., witness corner to corner of; iron post stamped "1805"	1,804.171

	Feet.
Tps. 150 and 151 N., R. 92 W., witness corner to corner of secs. 1, 2, 36, and 35; iron section post stamped "1813"	1,812.40
Tps. 150 and 151 N., R. 92 W., witness corner to corner of secs. 2, 3, 34, and 35; iron section post stamped "1845"	1,844.54
Tps. 151 and 152 N., R. 92 W., quarter corner between secs. 3 and 34; top of stone	1,890.52
Tps. 151 and 152 N., R. 92 W., witness corner to corner of secs. 3, 4, 33, and 34; iron section post	1,912.39
Tps. 151 and 152 N., R. 92 W., witness corner to corner of secs. 4, 5, 32, and 33; iron section post stamped "1890"	1,889.07
Tps. 151 and 152 N., R. 92 W., quarter corner between secs. 5 and 32; stone	1,903.17

RYDER QUADRANGLE.

Corner of secs. 2, 3, 34, and 35, Tps. 149 and 150 N., R. 89 W., east along township line to east boundary of reservation, thence north along reservation line to Minneapolis, St. Paul & Sault Ste. Marie Ry., thence northwest to north boundary of reservation, thence west along boundary to line between secs. 10 and 11, T. 152 N., R. 89 W.

Tps. 149 and 150 N., R. 89 W., corner of secs. 2, 3, 34, and 35; top of stone	1,942.49
Tps. 149 and 150 N., R. 89 W., quarter corner between secs. 2 and 35; top of stone	1,930.56
Tps. 149 and 150 N., R. 89 W., corner of secs. 1, 2, 35, and 36; top of stone	1,913.10
Tps. 149 and 150 N., R. 89 W., quarter corner between secs. 1 and 36; top of stone	1,935.69
Tps. 149 and 150 N., Rs. 88 and 89 W., corner of townships; top of stone	1,936.96
Tps. 149 and 150 N., Rs. 88 and 89 W., witness corner to corner of; iron post stamped "1937"	1,936.400
Tps. 149 and 150 N., R. 88 W., at corner of secs. 5, 6. 31, and 32; top of stone	1,952.59
Tps. 149 and 150 N., R. 88 W., quarter corner between secs. 5 and 32; top of stone	1,968.84
Tps. 149 and 150 N., R. 88 W., corner of secs. 4, 5, 32, and 33; top of stone	1,982.18
Tps. 149 and 150 N., R. 88 W., quarter corner between secs. 4 and 33; top of stone	1,996.01
Tps. 149 and 150 N., R. 88 W., corner of secs. 3, 4, 33, and 34; top of stone	2,016.49
Tps. 149 and 150 N., R. 88 W., quarter corner between secs. 3 and 34; top of stone	2,041.94
Tps. 149 and 150 N., R. 88 W., corner of secs. 2, 3, 34, and 35; top of stone	2,040.83
Tps. 149 and 150 N., R. 88 W., quarter corner between secs. 2 and 35; top of stone	2,040.37
Tps. 149 and 150 N., R. 88 W., corner of secs. 1, 2, 35, and 36; top of stone	2,040.47
Tps. 149 and 150 N., R. 88 W., quarter corner between secs. 1 and 36; top of stone	2,056.06
Tps. 149 and 150 N., Rs. 87 and 88 W.; top of stone	2,087.16
Tps. 149 and 150 N., Rs. 87 and 88 W., at witness corner to corner of; iron post stamped "2088"	2,087.563
Tps. 149 and 150 N., R. 87 W., quarter corner between secs. 6 and 31; top of stone	2,070.29
Tps. 149 and 150 N., R. 87 W., corner of secs. 5, 6, 31, and 32; top of stone	2,097.43
Tps. 149 and 150 N., R. 87 W., quarter corner between secs. 5 and 32; top of stone	2,101.36
Reservation boundary, third fence post north of gate where Northern Pacific Ry. location survey enters reservation fence; doubled nail, evidently a bench mark of the Northern Pacific Ry	2,099.47

	Feet.
Reservation boundary mile post 18, on east boundary of reservation; 3-inch iron post stamped "2102"	2,100.720
Milepost 19, 212 feet north of, 8 feet west of fence; point on bowlder	2,129.59
Milepost 19½, 450 feet south of, 30 feet west of fence; point on bowlder	2,145.74
Milepost 24, 0.2 miles south of, west of reservation fence; point on rock	2,175.66
Milepost 24, 0.7 mile north of, in north edge of dry lake bed; point on granite bowlder 0.5 by 2 by 2.5 feet	2,149.69
Milepost 27, 0.5 mile north of, near southwest edge of dry pond; point on white granite rock	2,133.58
Milepost 28, in vicinity of, 100 feet east of reservation fence on point of hill; top of white granite bowlder 3 by 1 by 2 feet	2,162.88
Milepost 30, iron post stamped "2114"	2,112.762
Reservation boundary, intersection with Great Northern Ry. location survey; top of rail	2,103.5
Reservation boundary, 950 feet west of, opposite station 5177; Great Northern Ry. bench mark stamped "2095.97," railway corrected elevation 2,096.71 feet	2,099.92
Reservation, east boundary, 3.8 miles northwest of, close to south side of right of way of Minneapolis, St. Paul & Sault Ste. Marie Ry.; point on large bowlder	2,087.02
Reservation, north boundary, 0.3 mile southeast of, top of bowlder 1 by 1 by ½ foot, 200 feet south 30° east of Minneapolis, St. Paul & Sault Ste. Marie Ry. milepost 500 and south of east end of snow fence	2,056.01
T. 152 N., R. 88 W., 70 feet southeast of intersection of section line between secs. 8 and 9 with reservation boundary, south of Plaza; top of gray bowlder	2,084.22
T. 152 N., R. 88 W., north boundary of reservation, at intersection of secs. 7 and 8; top of stone	2,076.02
T. 152 N., Rs. 88 and 89 W., intersection of range line with reservation boundary; top of stone marker	2,056.26
T. 152 N., Rs. 88 and 89 W., intersection of range line with reservation boundary; top of post marked "2058"	2,057.137
T. 152 N., R. 89 W., intersection of secs. 11 and 12 with reservation boundary; top of stone marker	2,053.77

Tps. 150 and 151 N., on east boundary of reservation, west along township line to R. 88 W., quarter corner between secs. 6 and 31.

Milepost 24, at point on Indian reservation boundary; iron post stamped "2173"	2,172.053
Tps. 150 and 151 N., R. 87 W., quarter corner between secs. 5 and 32; iron section post stamped "2166"	2,165.45
Tps. 150 and 151 N., R. 87 W., quarter corner between secs. 6 and 31; iron section post stamped "2175"	2,174.15
Tps. 150 and 151 N., Rs. 87 and 88 W., corner of; iron post stamped "2172"	2,171.637
Tps. 150 and 151 N., R. 88 W., quarter corner between secs. 6 and 31; iron section post stamped "2166"	2,165.25
Tps. 150 and 151 N., R. 88 W., corner of secs. 1, 2, 35, and 36; iron section post	2,158.04
Tps. 150 and 151 N., R. 88 W., quarter corner between secs. 2 and 35; iron section post stamped "2151"	2,153.71
Tps. 150 and 151 N., R. 88 W., quarter corner between secs. 3 and 34; iron section post stamped "2105"	2,104.19
Tps. 150 and 151 N., R. 88 W., corner of secs. 3, 4, 33, and 34; iron section post stamped "2102"	2,101.316

	Feet.
Tps. 150 and 151 N., R. 88 W., quarter corner between secs. 4 and 33; iron section post stamped "2120"	2,118.85
Tps. 150 and 151 N., R. 88 W., corner of secs. 4, 5, 32, and 33; iron section post	2,112.23
Tps. 150 and 151 N., R. 88 W., quarter corner between secs. 5 and 32; iron section post stamped "2079"	2,078.38
Tps. 150 and 151 N., R. 88 W., corner of secs. 5, 6, 31, and 32; iron section post	2,088.57
Tps. 150 and 151 N., R. 88 W., quarter corner between secs. 6 and 31; iron section post stamped "2081"	2,080.81

BLUE BUTTE QUADRANGLE.

T. 152 N., R. 92 W., corner of secs. 5, 6, 31, and 32, northeast and northwest to Missouri River Commission bench mark 148/2.

Tps. 151 and 152 N., R. 92 W., witness corner to corner of secs. 5, 6, 31, and 32; iron section post stamped "1940"	1,939.16
Tps. 151 and 152 N., Rs. 92 and 93 W., 18 inches north of corner of townships; iron post stamped "1975"	1,974.451
T. 152 N., R. 92 W., quarter corner of secs. 30 and 31; iron section post	1,980.19
Little Knife River, 0.25 mile below mouth of, on east bank of Missouri River, 525 feet from Missouri River; Missouri River Commission bench mark 148/2; top of cap of post	1,885.346
Subsurface mark at bottom of post	1,881.390

Missouri River Commission bench mark 148/2 to and across the Missouri River, thence southwest to bench mark at closing corner of secs. 12 and 13, T. 151 N., R. 95 W.

Fort Berthold Reservation line, 2,000 feet south of; Missouri River, surface of water, Oct. 17, 1910	1,766
Bad Lands Bluffs, 0.25 mile east of foot of, 25 feet south of reservation boundary fence, 150 feet west of brush on river bottom, in southwest root of partly dead 18-inch cottonwood tree; wire fence staple	1,788.18
T. 152, Rs. 93 and 94, corner secs. 19, 24, 25, and 30; north edge of stone	2,034.71
Tps. 151 and 152 N., R. 94 W., 0.5 mile northeast of witness corner to corner of secs, 3, 4, 33, and 34, 0.25 mile east of small clay butte on north side of canyon 150 feet deep; rock	2,096.66
Tps. 151 and 152 N., R. 94 W., 3.35 chains east of corner of secs. 3, 4, 33, and 34; iron post stamped "2136"	2,135.444
T. 151 N., R. 95 W., at point 1 foot east of stone marking closing corner between secs. 12 and 13, on west boundary of Fort Berthold Indian Reservation; iron post stamped "2067"	2,065.898
T. 151 N., R. 95 W., at closing corner secs. 12 and 13; top of stone marked "2067"	2,065.79

Ray and White Earth Quadrangles.

WALLACE, WARD, AND WILLIAMS COUNTIES.

The elevations in the following list are based upon levels of the Missouri River Commission to which the orthometric correction has been applied, and are in agreement with the 1907 adjusted elevation at Sioux City, Iowa, as made by the Coast and Geodetic Survey.

The leveling in the Ray quadrangle was done in 1906 by W. A. Gelbach and in 1909 by J. H. Van Wagener and C. A. Leonard, and that in the White Earth quadrangle in 1909 by Van Wagener.

RAY QUADRANGLE.

Point near Missouri River near southwest corner of T. 153 N., R. 99 W., north along township line to Great Northern Ry.

	Feet.
T. 153 N., R. 100 W., northeast corner of SE. ¼ sec. 36, 0.8 mile slightly east of north from John Kjorstad's house, 25 feet south of trail to house; iron post stamped "No. 135-2 of Missouri River Commission;" bolt underground	1,892.693
T. 153 N., R. 99 W., northwest corner of, 25 feet north of corner stone; iron post stamped "2249"	2,248.048
T. 154 N., R. 99 W., northwest corner of sec. 19; iron post stamped "2233"	2,232.375
T. 154 N., R. 99 W., northwest corner of, 8 feet north of corner stone; iron post stamped "2211"	2,210.263

Springbrook along Great Northern Ry. to Ray.

Springbrook, 5 feet from northwest corner of Graichen's hardware store; iron post stamped "2072"	2,070.553
T. 155 N., R. 99 W., northwest corner of sec. 3, 5 feet west of corner stone; iron post stamped "2135"	2,133.570
Epping, between First State Bank and Torgerson, Aaberg & Swenson Co.'s store, flush with front of buildings; iron post stamped "2224"	2,222.543
Wheelock, Lofgren Bros.' store, 20 feet from southwest corner, 2 feet south of store; iron post stamped "2395"	2,393.777
T. 156 N., R. 97 W., northwest corner of sec. 30, 35 feet northeast of, east of track, north of railroad crossing; iron post stamped "2345"	2,344.159
Ray, Smith Hotel, 6 feet from southwest corner, on south side, in foundation wall; tablet stamped "2277"	2,275.689

Ray south through ranges 97 and 96 west to Missouri River.

T. 155 N., R. 97 W., 1,000 feet west of northwest corner of sec. 2, where Nesson trail crosses section line; iron post stamped "2260"	2,258.904
T. 154 N., R. 96 W., 25 feet northwest of northwest corner of sec. 5; iron post stamped "1922"	1,921.232
Nesson, 3.5 miles southeast of, 1,000 feet southeast along foot of bluff from Edward Richard's house; Missouri River Commission bench mark 142-2; underground mark	1,815.404

Northwest corner of sec. 20, T. 154 N., R. 96 W., west along Williston Road to west boundary of range 99 W.[1]

Cussick Springs, 30 feet east of road south of trail; iron post stamped "2298"	2,296.916
T. 155 N., R. 98 W., 70 feet north of quarter corner on west side of sec. 2; iron post stamped "2437"	2,436.268
T. 154 N., R. 98 W., 25 feet north of quarter corner on west side of sec. 18; iron post stamped "2387"	2,385.798
T. 154 N., R. 99 W., 15 feet south of quarter corner on west side of sec. 21; iron post stamped "2264"	2,263.289

Point on Great Northern Ry. 2.5 miles east of Epping north and east via Angle post office and south to Ray.[2]

T. 156 N., R. 99 W., 30 feet south of northwest corner of sec. 15; iron post stamped "2353"	2,351.770
T. 157 N., R. 98 W., 300 feet west and across creek from sec. 30; iron post stamped "2121"	2,119.773

[1] An excessive error of 1.2 feet has been distributed in this line.
[2] An excessive error of 0.82 foot has been distributed in this line.

	Feet.
T. 157 N., R. 98 W., 35 feet north by 35 feet east of northwest township corner; iron post stamped "2285"	2,284.203
T. 157 N., R. 98 W., 35 feet north by 30 feet east of northwest corner of sec. 3; iron post stamped "2306"	2,304.414
T. 157 N., R. 97 W., 35 feet north by 35 feet west of northwest corner of sec. 5; iron post stamped "2229"	2,227.747
T. 157 N., R. 97 W., 45 feet north by 40 feet west of northwest corner of sec. 1; iron post stamped "2274"	2,273.081
T. 157 N., R. 97 W., 35 feet south by 30 feet west of northwest corner of sec. 25; iron post stamped "2316"	2,314.809

Frische's ranch (formerly Banks post office) west along highways 1.1 miles, thence south 7 miles, thence west to Missouri River Commission bench mark 138-2.

Frische's ranch (formerly Banks post office), about 0.4 mile west of, 30 feet south of road leading up coulee; highest point of large white stone 3 feet in diameter marked "U. S. 1896.8 B. M."	1,895.94
Frische's ranch, 1.1 miles west of, 250 feet west of point where road comes up out of coulee on ridge, 105 feet south of road, 100 feet north of brush in small coulee; center of top of white stone 1.5 feet in diameter marked "U. S. 2094.1 B. M."	2,093.26
Frische's ranch, Tobacco triangulation station (Missouri River Commission); top of triangle on cap of iron post marked M R / U △ S / C O M M	2,140.163
Frische's ranch, about 3 miles southwest of, 1.2 miles south of Tobacco triangulation station, 200 feet east of road on ridge, 150 feet north of small trees in head of coulee, 40 feet west of stone 2.5 feet in diameter and 2.5 feet high; highest point on west end of triangular pink stone 3 feet across and 1 foot high marked "U. S. 2142.9 B. M."	2,142.09
T. 153 N., R. 96 W., 40 feet northeast of southwest corner of sec. 17; iron post stamped "2288"	2,287.266
T. 153 N., R. 96 W., near east-west section line between secs. 29 and 20, 16 feet west of road, 500 feet north of black shanty, top of stone 5 feet long, projecting out of ground about 1 foot, marked "U. S. 2318.2 B. M."	2,317.40
T. 152 N., R. 97 W., NW. ¼ sec. 1, 40 feet southwest of township corner between secs. 32 and 33, T. 153 N., R. 96 W.; iron post stamped "2380".	2,379.314
T. 153 N., R. 97 W., SW. ¼ sec. 36, near standard parallel about 0.5 mile east of southwest corner of sec. 36, in saddle between two knolls, 700 feet north of ditch, 200 feet northeast of large stone on side of hill; top of pink rock 2 feet in diameter, projecting about 1 foot from ground, marked "U. S. 2152.8 B. M."	2,152.17
T. 153 N., R. 97 W., 40 feet east of township line, secs. 35 and 36; iron post stamped "1994"	1,993.135
T. 153 N., R. 97 W., SE. ¼ sec. 34, 1,000 feet west of Tobacco Garden Creek, 700 feet northwest of old sod house on north side of coulee; rock about 2 feet in diameter, projecting 1 foot from ground, marked "U. S. 1953.5 B. M."	1,952.877
T. 153 N., R. 97 W., secs. 32 and 33, township line; top of stone marked "U. S. 2121.6 B. M."	2,120.99
T. 153 N., R. 97 W., 30 feet west of standard corner of secs. 31 and 32, 400 feet north of house; iron post stamped "2061"	2,060.15
T. 153 N., R. 97 W., 1.5 miles southeast of standard corner of secs. 31 and 32, in saddle between two knolls near top of divide; large bowlder marked "2228.4"; cut in stone -○-	2,227.85
T. 152 N., R. 98 W., 2 feet north of closing corner of secs. 4 and 5. 200 feet south of road down coulee; iron post stamped "2237"	2,236.81

	Feet.
T. 153 N., R. 98 W., NE. ¼ sec. 34, at mouth of coulee, 50 feet east of road, on top of first bench above river; iron post stamped "1852"	1,851.275
T. 153 N., R. 97 W., in sec. 21, Missouri River Commission bench mark No. 138–2, on north bank, 250 feet from river, in mouth of double coulee just above the beginning of willows; top of cap of iron post	1,852.795

WHITE EARTH QUADRANGLE.

Missouri River Commission bench mark 144–1 west along highways to Frische's ranch (formerly Banks post office).

Grinnel's Landing, 2.4 miles below, 1,750 feet from river, nearly south of mouth of small coulee, on a mound; top of cap of iron post (Missouri River Commission bench mark No. 144–1)	1,994.108
Missouri River Commission bench mark 144–1, 0.7 mile west of, on west bank of first coulee, about 500 feet south of mouth and 400 feet south of road, 18 feet north of black and white speckled stone about 2 feet in diameter; light pink stone 14 inches in diameter marked "U. S. 1858.4 B. M."	1,857.38
T. 154 N., R. 96 W., NE. ¼ sec. 33, 3 feet southeast of 2-foot elm tree, 8 feet north of road, 50 feet south of log house about halfway between Grier's house and Frische's house, in river bottom; iron post stamped "1820"	1,818.640

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